L'analyse des comportements de fécondité : politiques publiques et facteurs culturels

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THESE DE DOCTORAT

présentée et soutenue publiquement par

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le 26 novembre 2008

L'ANALYSE DES COMPORTEMENTS DE FECONDITE: POLITIQUES PUBLIQUES ET FACTEURS CULTURELS

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Remerciements

Les remerciements... voila probablement la partie la plus lue d'une thèse, d'autant plus si cette dernière est écrite en France dans la langue de Shakespeare (ou enfin presque...). Les écrire est l'occasion de me rappeler que je n'ai jamais été seul pendant les quatre années (voire un peu plus) qui viennent de s'écouler. J'espère que les lignes que je m'apprête à écrire ne seront ni répétitives ni par trop banales car les personnes à qui je les consacre en sont tout le contraire.

Il me serait bien difficile de commencer sans remercier Bertrand Wigniolle, non pas parce qu'il est de tradition de remercier en premier lieu son directeur de thèse mais parce qu'il a été le premier artisan de tout ce qu'il y a de bon dans les chapitres qui vont suivre. J'ai débarqué pour la première fois dans son bureau après qu'il ait accepté d'encadrer mon mémoire de DEA, je pense être, depuis, un des pensionnaires les plus assidus de cet endroit. J'y ai toujours trouvé une oreille attentive, de la bonne humeur et des solutions à la plupart de mes problèmes. Bertrand a fait preuve d'une patience incroyable face à mes lenteurs et si ses standards de rigueur m'ont souvent plongé dans des questionnemenents sans fin, ils m'ont fait avancer et le feront encore longtemps.

Je tiens également à chaleureusement remercier les membres de mon jury. Leurs remarques, lors de ma pré-soutenance, ont indéniablement contribué à améliorer la qualité de mon travail. J'ai essayé de prendre en compte un maximum de leurs conseils pour rédiger cette thèse, ceux que je n'ai pas eu le temps d'intégrer le seront immanquablement par la suite. Hippolyte d'Albis et David de la Croix ont accepté

d'être les rapporteurs de ma thèse. C'est un grand honneur pour moi et je leur en suis reconnaissant. Ils se sont, tous deux, avérés d'excellent conseil pendant ces quatre années. J'espère sincèrement que mes valises se poseront prochainement dans une petite ville du Brabant wallon où je pourrai encore apprendre beaucoup... Je garde un souvenir impérissable de mes premières Journées Générations Imbriquées à Nantes. Cette présentation, l'une de mes premières, fût l'occasion de rencontrer Pierre Pestieau pour la première fois. Ses vigoureuses et bienveillantes remarques lors de ma pré-soutenance porteront longtemps leurs fruits. Le troisième chapitre de ma thèse n'aurait pu voire le jour sans Luc Arrondel qui, sans même me connaître, m'a autorisé à exploiter la base de données issue de l'"Enquête Mode de Vie des Français". J'en profite d'ailleurs pour remercier Jean-Marc Tallon qui a intercédé en ma faveur auprès du Projet Prince qui me pardonnera, je l'espère, de ne pas mentionner l'interminable suite de chiffres dont l'administration l'a affublé. A mon arrivée à Paris, Antoine d'Autume m'a enseigné la macroéconomie et l'optimisation dynamique. Il n'a cessé, depuis, de porter une bienveillante attention à mes travaux. Ses conseils m'ont toujours été très utiles et avoir fait partie de son équipe pédagogique a été réel un plaisir.

Je remercie Thomas Seegmuller qui m'a apporté une aide salvatrice aux moments clés de ma thèse. D'incitations à généraliser en conseils pour mieux présenter, il est devenu un acteur majeur de mes premiers pas dans le monde de la recherche... et dans certains bars marseillais.

Effectuer ma thèse à EUREQua m'a permis de bénéficier de conditions de travail dont il serait bien difficile de se plaindre. Je remercie particulièrement Jean-Olivier Hairault, directeur de cette équipe de recherche. J'en profite pour également remercier Katheline Schubert, Mouez Fodha et Fabio Mariani dont l'écoute et la bonne humeur sont toujours un réel plaisir. EUREQua et le programme doctoral ETAPE bénéficient du travail de Viviane Makougni, Elda André et Eric Zyla. Entrer dans un bureau sans craindre la moindre inefficacité, en ayant le sourire et sachant qu'il

est possible de parler de bien plus que de démarches administratives, voila qui a été des plus agréable.

J'ai, cette année, décidé d'exporter mes minces talents d'enseignants dans la ville de Lille, contrée qui me tient particulièrement à cœur. Je remercie Frédéric Jouneau d'avoir eu la bonne idée de me recruter en tant qu'ATER à l'université Lille III Charles de Gaulle et de m'avoir déchargé de presque toute obligation pédagogique en ce premier semestre. Mon accueil à Lille III a été des plus chaleureux, j'en remercie l'ensemble de mes nouveaux collègues et plus particulièrement Luc Champarnaud et Gérard Hamiache.

J'ai déjà remercié tant de personnes... Il y en a pourtant trois sans lesquelles je ne serai pas en mesure d'écrire ces remerciements : Natacha Raffin, Marie-Pierre Dargnies et Victor Hiller. Vous m'avez ouvert vos vies, vos maisons et vos soirées. Vous avez partagé mes doutes et mes galères, vous m'avez soutenu dans les moments décisifs. Je vous dois tant que je ne saurai vous remercier assez que par mon indéfectible amitié... et quelques bières ou jus de tomate. J'ai, depuis mon arrivée à Paris, rencontré des personnes dont l'amitié me touche au plus haut point, je pense particulièrement à Gunes Kamber, Xavier Deleau, Sumudu Kankanange et Mohamad Khaled... tous ex-membres du DEA Macro promotion 2004. Clémence Berson s'est récemment ajoutée à cette liste et l'a formidablement enrichie.

Je tiens également à remercier Magalie Recoules pour sa relecture dans l'urgence de l'introduction de mon second chapitre. La vie à EUREQua m'a été agréable, les doctorants du groupe de travail Macro (appellation ancestrale du PhD Macro Workshop de Paris I) y ont également été pour beaucoup. J'espère n'oublier personne en évoquant, en plus de tous ceux déjà cités, Fabienne Llense, Dramane Coulibaly, Christophe Hachon, Ekrame Boubtane et Florent Buisson. Les "anciens" du labo m'ont également réservé un accueil chaleureux. Je pense particulièrement à Lucie Ménager, Audrey Desbonnet, Nicolas Houy, Paul Cahu, Falilou Fall, Chahnez Boudaya, Nicolas Millon et Morgane Tanvé à qui j'envoie tous mes encouragements.

J'y inclus bien évidemment Sébastien Le Coent dont les valises se sont récemment posées en Allemagne.

Je ne saurai oublier également toutes ces personnes avec lesquelles j'ai également partagé ces dernières années : Jean-Pierre Drugeon avec qui j'ai partagé d'enrichissantes conversations et des tribulations hongroises, Jeanne Hagenbach, Chantale Marlats, Antoine Berthou, Julien Vauday et Vincent Vicard.

Tous ces remerciements n'auraient jamais existé si, dans une petite université du littoral de la Côte d'Opale, ma route n'avait pas croisé celle de Rodrigue Mendez. Mon arrivée dans le DEA Macro de Paris I lui doit beaucoup. Rodrigue m'a initié, au cours de mon mémoire de maîtrise aux modèles à fécondité endogène et aux modèles OLG. Il semble bien qu'il ait réussi à m'y intéresser... Je ne pourrai également oublier Patrice Gaubert et Pascal Cormier qui m'ont très tôt encouragé dans la voie de la thèse.

Quelques personnes m'ont soutenu par leur amitié sans jamais vraiment bien comprendre ce que j'ai pu faire à l'université pendant plus de quatre ans pour finalement ne produire qu'un peu moins de 200 pages... je pense particulièrement à Johan, Delphine, Stéphanie et Bertrand. Ma famille a fait preuve de bienveillance et d'une vraie confiance dans mes choix. Nous sommes récemment passé par de drôles d'épreuves mais nous les avons traversées ensemble et finalement sans trop de dommage.

Enfin, mes derniers mots sont destinés à Audrey. Tu peux deviner tout ce que j'aimerai te dire ici mais que je vais garder pour moi... Rien ne serait pareil sans toi.

Résumé

De l'an 1 après Jésus Christ à 2008, la population mondiale est passée de 170 millions d'individus[1] à 6,705 milliards[2]. Cette croissance exponentielle a donné naissance à bon nombre de craintes et de débats à propos de la croissance démographique le plus souvent décrite comme trop forte dans les pays en développement et trop faible dans les pays développés. Mener de tels débats sous-tend l'existence d'un taux de croissance optimal de la population ainsi que d'une taille optimale pour la population mondiale.

Les économistes montrent qu'affirmer l'existence d'une taille optimale de la population soulève des questions complexes. Par exemple, une petite population bénéficiant d'un haut niveau de vie est-elle préférable à une grande population bénéficiant d'un plus faible niveau de vie? La réponse à cette question s'avère profondément liée à la manière dont on évalue la vie d'agents qui auraient pu naitre mais qui ne sont finalement pas nés. De plus, si l'on peut parvenir à définir une taille optimale de la population, il faut se demander pourquoi les choix individuels écartent la société de cette situation la plus désirable.

Pour juger du bien-fondé de la croissance démographique que connait notre monde, il est également fondamental de comprendre le lien entre croissance de la population et développement. S'il ne fait aucun doute que de grandes populations épuisent plus rapidement les ressources non renouvelables, l'Histoire Economique nous apprend que l'accroissement de la taille des populations est la cause d'un grand nombre d'avancées dans le monde. En effet, la pression des populations sur les ressources est un moteur de l'innovation qui, en retour, accroît la quantité de ressources disponibles. De plus, les évidences empiriques indiquent que le processus de développement n'est pas neutre pour la croissance démographique. Une grande part de l'humanité a connu une transition démographique menant à la réduction, à long terme, à la fois de la mortalité et de la fécondité et à une hausse temporaire du taux de croissance de la population. Comprendre les déterminants de ce processus pourrait permettre de déterminer les conditions sous lesquelles les pays en développement achèveront de stabiliser la taille de la population mondiale.

Ma thèse apporte une contribution à l'effort continu des économistes pour comprendre les déterminants de la population et son impact sur le bien-être de l'humanité. Cette thèse

[1] Estimation from the US Census Bureau.

[2] Estimation from World Population Datasheet 2008.

se concentre particulièrement sur les comportements de fécondité, déterminant majeur de la croissance démographique.

La relation entre science économique et phénomènes démographiques prend racine dans l'analyse économique des Classiques. Les économistes Classiques ont endogénéisé les variables démographiques dans leur représentation globale de l'économie. Birdsall [1988] divise les Classiques entre pessimistes et optimistes. La plus célèbre théorie pessimiste est celle de Malthus. Dans son Essaie sur le Principe de Population [1798], les fluctuations économiques et démographiques sont déterminées par les comportements de reproduction à l'échelle familiale et ces comportements maintiennent l'économie dans une perpétuelle pauvreté. Malthus affirme que lorsque les revenus s'élèvent au dessus de leur niveau de subsistance, les individus, en moyenne, se marient plus tôt et ont plus d'enfants, ces derniers font face à une plus faible mortalité grâce a une alimentation améliorée. L'accroissement de la population accroit l'offre de travail et la demande de nourriture à la période suivante. Les rendements décroissants du travail et de la terre impliquent que les salaires décroissent alors que les prix de la nourriture augmentent: le revenu tombe en dessous de son niveau de subsistance, les mariages et la fécondité décroissent alors que la mortalité augmente. L'économie en revient finalement à sa situation de long terme où la taille de la population et le niveau de vie sont stables.

Ricardo [1817] propose une analyse relativement proche de celle de Malthus quant à la relation entre dynamique économique et dynamique démographique. Il affirme qu'à long terme, les salaires ne peuvent s'écarter de leur prix naturel. La décroissance des rendements du travail et de la production de céréales rendent inévitable la convergence vers ce prix naturel. Cependant, le pessimisme de Ricardo doit être relativisé car ce dernier propose trois mécanismes pour s'échapper de la trappe de non développement: (i) les améliorations de l'agriculture, de l'accumulation du capital, de la division du travail et l'ouverture de nouveaux marchés, (ii) l'accroissement du taux de salaire de subsistance qui peut dissocier salaire de subsistance et fécondité élevée (Ricardo précise que la définition du salaire de subsistance est sociale plutôt que biologique), (iii) l'apparition du contrôle des naissances qu'il présente comme le moyen ultime pour éradiquer la surabondance démographique.

Tous les économistes Classiques n'ont toutefois pas développé des thèses pessimistes.

Dans la Richesse des Nations [1776], Adam Smith affirme que la croissance démographique accélère la croissance économique: une plus grande population accroit la taille du marché, ce qui incite à l'innovation, approfondi la division du travail et finalement améliore la productivité. Marshall [1920], un des fondateurs de l'Economie Néoclassique, affirme également que de plus grandes populations permettent à l'économie de s'amender des rendements décroissants. Il se concentre sur la relation entre santé et force physique et mentale. Il souligne l'importance de l'accroissement du savoir particulièrement dans le domaine de la médecine. Un plus grand savoir permettra d'améliorer la santé, réduire la mortalité, améliorer l'efficacité des travailleurs et, finalement, accroître la production. Contrairement à Malthus et Ricardo, Smith et Marshall n'ont pas donné une place centrale à l'interaction entre comportements économiques et démographiques. Ils n'ont, dès lors, pas proposé une théorie optimiste globale sur le lien entre croissance démographique et croissance économique.

Le décollage des économies européennes lors de la Révolution Industrielle a rapidement invalidé les conclusions malthusiennes et ricardiennes. En effet, après le début de la Révolution Industrielle (aux alentours de 1820), la corrélation entre croissance de la population et croissance économique est devenue positive[3]. Cet échec peut être considéré comme une des raisons pour lesquelles la révolution marginaliste a d'abord négligé l'analyse des comportements de fécondité. Une autre raison au fait qu'appliquer le concept de rationalité à l'analyse des comportements de fécondité dépassait les limites du politiquement correct. Quelqu'en soit la raison, l'économie moderne a débuté son histoire sans appliquer le concept de rationalité à l'analyse des comportements de fécondité. Dès lors, l'opposition entre optimistes et pessimistes est devenue moins visible et la fécondité a été traitée comme une variable exogène.

Même dans leurs modèles de croissance, Solow [1956] et Ramsey [1928] assument une croissance exogène de la population. Ils la représentent comme un frein à la croissance de la consommation et comme pénalisant le niveau de consommation de long terme. Toutes les extensions de ces cadres d'analyse (par exemple, Lewis [1954], Mankiw et al [1992], Lucas [1988], ...) affirment que, toute chose égale par ailleurs, une plus forte croissance de la population implique une plus faible productivité du travail. Pour atteindre le même niveau

[3]See, for instance, Galor [2005a, 2005b].

de capital par tête, il est alors nécessaire d'épargner plus et donc de consommer moins.

Une fois encore, les approches optimistes se concentrent sur les effets d'échelle. Par exemple, Boserup [1965] et Simon [1981] montrent que de plus grandes populations exercent une pression à l'innovation et permettent des économies d'échelle. Contrairement aux modèles de croissance à la Solow-Ramsey, les modèles de croissance endogène affirment que la taille de la population a un effet positif sur la croissance du revenu par tête (voire, par exemple, Aghion & Howitt [1998]). Cet effet taille a été fortement critiqué (voire Amable [2000]), car il est en grande partie contrefactuel. Les contributions de Eicher & Turnovski [1999] and Jones [1999][4] suppriment cet effet taille. Jones [1999] propose un modèle de croissance semi endogène où la croissance exogène de la population a un impact positif sur la croissance du revenu par tête. Ce résultat est dû aux rendements croissants dans le secteur de l'innovation.

Dans le même temps, une vaste littérature affirme qu'une étude globale des comportements de fécondité et de leurs effets sur la croissance économique est impossible car ils ne sont constants ni dans le temps ni dans l'espace. Cette littérature propose une étude purement empirique plutôt que théorique de ces phénomènes[5]. Elle ne parviendra finalement pas à mesurer proprement l'impact de la croissance de la population sur l'épargne, les taux d'éducation, les dépenses de santé et les inégalités de revenus. En refusant toute modélisation des comportements de fécondité, ces études ne peuvent se prémunir contre les biais d'endogénéité et contre la critique de Lucas [1976].

L'économie démographique est entrée dans son ère moderne grâce aux contributions de Becker et d'Easterlin qui ont utilisé les outils de la Révolution Marginaliste pour analyser les comportements de fécondité. Malgré leur profonde opposition sur l'endogénéité des goûts, ces deux approches peuvent être réunies sous l'appellation Marginaliste; elles sont également, toutes deux, des héritières des théories Malthusiennes et Ricardiennes car elles supposent que les comportements de fécondité au sein de la famille sont déterminés par l'environnement économique qui est, en retour, influencé par les comportements de fécondité. La Révolution Marginaliste leur permet d'analyser ce phénomène avec plus de rigueur. L'opposition entre ces deux modèles a été cruciale pour le développement de l'économie démographique.

Le modèle Beckerien est issu des contributions de Becker [1960], Becker & Tomes [1973]

[4]See also, for instance, Segerstrom [1998] and Young [1998].

[5]Birdsall [1988] proposes an enlightening review of this "purely empirical" literature.

et Becker & Lewis [1976]. Dans leur cadre d'analyse, la fécondité, au niveau familial, est le résultat d'un processus de choix rationnel. Les parents sont altruistes dans le sens où ils incluent un indicateur du futur bien-être de leurs enfants dans leur propre fonction d'utilité. Dans la version la plus simple du cadre Beckerien, cet indicateur consiste en la qualité des enfants représentée par leur capital humain ou leur richesse. Dès lors, les parents valorisent à la fois la quantité de leurs enfants (le nombre d'enfants mis au monde) et leur qualité, en plus des commodités usuelles déjà présentes dans le modèle standard de choix du consommateur. Les parents doivent alors déterminer leur arbitrage optimal entre qualité et quantité.

Déterminer le choix optimal de quantité et de qualité ne relève pas d'un problème microéconomique standard car les parents font face à une contrainte de budget non linéaire. En effet, qualité et quantité entrent de manière multiplicative dans la contrainte de budget parentale. Dès lors, le coût relatif entre qualité et quantité dépend du choix en terme de qualité et quantité: le coût marginal de la quantité est croissant avec la qualité. En d'autres termes, avoir un enfant de plus sera d'autant plus couteux que l'investissement dans la qualité de chaque enfant est important. De même, fournir une unité de qualité en plus par enfant sera d'autant plus couteux que les parents décident d'avoir un grand nombre d'enfants.

Comme le mentionnent Hotz et al [1993], un défi majeur pour le modèle Beckerien est d'expliquer pourquoi les familles à hauts revenus ont tendances à avoir moins d'enfants que les familles à faibles revenus et pourquoi, une hausse des revenus est associées à une baisse de la fécondité. Le modèle Beckerien affirme que la fécondité optimale diminue lorsque les revenus augmentent car les parents sont incités à substituer de la qualité à la quantité. Deux mécanismes peuvent être à l'œuvre pour expliquer cette substitution. Le premier est proposé par Becker & Lewis [1973] qui montrent que lorsque l'élasticité revenu de la demande de qualité est supérieure à l'élasticité revenu de la demande de quantité, les parents substituent de la qualité à la quantité lorsque leurs revenus s'accroissent. En effet, comme la qualité et la quantité sont supposées être des bien normaux, après une hausse du revenu parental, la demande de quantité et de qualité augmente a priori, et la demande de qualité augmente plus si son élasticité revenu est supérieure à celle de la quantité. Cependant, la non linéarité de la contrainte budgétaire des parents implique un second effet de substitution: comme la hausse de la demande de qualité est plus forte que celle de la demande de quantité, le prix de

la quantité augmente relativement au prix de la qualité. Les parents vont donc finalement substituer de la qualité à la quantité.

Le second mécanisme impliquant une substitution qualité quantité suite à une hausse du revenu tient à la nature spécifique des coûts liés à la quantité. Mincer [1963] affirme qu'élever des enfants est coûteux en terme de temps, particulièrement pour les femmes. Willis [1973] utilise cette hypothèse dans un modèle simple où les parents décident d'allouer leur temps entre élever leurs enfants et participer au marché du travail: élever des enfants implique un coût d'opportunité, celui du renoncement à participer au marché du travail. Cette hypothèse sera largement adoptée par la littérature (voire, par exemple, Galor [2005]): comme élever des enfants est l'activité familiale la plus intense en terme de temps, un accroissement des revenus du travail accroît le coût relatif de la quantité par rapport à la quantité et à toutes les autres commodités. Les parents réduisent donc leur fécondité et investissent plus dans la qualité de chaque enfant.

La représentation Beckerienne des comportements de fécondité a été rapidement concurrencée par la théorie d'Easterlin. Le modèle de fécondité de la Synthèse provient des contributions d'Easterlin [1978] et Easterlin et al [1980]. Plutôt qu'opposée au modèle Beckerien, Easterlin tente d'étendre ce dernier. Il accepte la représentation d'une famille rationnelle maximisant son utilité sous contrainte de prix et de revenu. Il vise, cependant, à concilier ce cadre d'analyse avec le modèle d'offre d'enfants des démographes et avec la détermination endogène des préférences[6]

Incorporer le modèle d'offre d'enfants consiste essentiellement à inclure de nouvelles variables tel que la fréquence des grossesses, la mortalité infantile et la désutilité des contraintes liées à la contraception. Cette partie du projet de recherche d'Easterlin consiste en une amélioration naturelle du cadre Beckerien. Sans avoir recours au modèle de la Synthèse, les modèles de fécondité de cycle de vie permettent de représenter les décisions optimales en terme de timing de la première naissance (voire, par exemple, Moffit [1984] et Happel [1984]), d'espacement des naissances suivantes et de contraception[7]. Une large littérature

[6]Birdsall [1988] proposes an elegant modelization of the Easterlin's contribution.

[7]Par exemple, Heckman & Willis [1975] et Wolpin [1984] montrent que les variations du profiil du revenu parental de cycle de vie a un impact sur le timing de la première naissance et sur l'espacement des naissances suivantes.lorsque l'accès au marché du capital est restreint. Ils montrent qu'une croissance rapide du revenu familial incite les parents à repousser la première naissance et espacer les suivantes. En effet, l'importance

modélise l'impact de la mortalité infantile sur les choix de fécondité sans avoir recours au modèle de la Synthèse[8]

L'endogénéité des goûts pour la fécondité et les commodités constitue le vrai point d'opposition entre Becker et Easterlin. Dans le modèle de la Synthèse, les normes sociales sont incluses comme un déterminant de la fonction d'utilité parentale. Les préférences déterminent les demandes individuelles de bien et d'enfants alors que les normes sociales déterminent les préférences. Pour une famille à court terme, ces normes sont exogènes et constantes. A long terme, cependant, l'évolution des normes, et particulièrement des normes de fécondité, est déterminée par les mutations de l'environnement économique.

Easterlin et ses successeurs ne sont pas parvenus à endogénéiser l'évolution de long terme des normes sociales. Ceci a rendu le modèle de la Synthèse vulnérable à la critique de Becker & Stigler [1977]: expliquer l'évolution des comportements par des changement de goûts fournit une infinité de degrés de liberté. La littérature a donc adopté l'approche "purement économique" de Becker pour représenter les comportements de fécondité et expliquer leurs principales évolutions.

Après avoir discuté ses fondations, l'économie démographique s'est engagée dans l'analyse de problèmes que les modèles standards ne pouvaient investir de manière satisfaisante. Parmi ces problèmes, la transition démographique et les implications en terme de bien-être des comportements individuels de fécondité ont émergé comme deux enjeux majeurs. Les trois chapitres qui composent cette thèse tentent d'apporter une contribution à l'étude de ces questions.

1 Premier Chapitre: Politiques Familiales: que nous enseigne le modèle Beckerien standard?

Analyser l'optimalité des comportements de fécondité nécessite de répondre à trois questions principales: "Comment définir l'optimalité lorsque la taille de la population est endogène?", "Quel est alors un bon objectif de bien-être social?" et "Pourquoi les choix individuels de

du flux relatif de services provenant des enfants se réduit par rapport aux revenus du travail alors que les coûts d'élever les enfants restent inchangés.

[8] Voire Sah [1991], Kalemli-Ozcan [2003], Ehrlich & Lui [1991], Barro & Becker [1988], Cipriani & Blackburn [1998], etc.

fécondité peuvent s'éloigner de l'équilibre optimal?"

1.1 Les concepts d'optimalité et de bien-être social lorsque la fécondité est endogène

Comment définir l'optimalité lorsque la fécondité est endogène?

Appliquer le concept d'optimalité aux variables démographique n'est pas évident. La littérature a fortement évolué depuis l'approche séminal de Samuelson [1975]. Samuelson suppose une fécondité exogène et se concentre sur la question du taux de croissance optimal de la population dans un modèle à générations imbriquées. Un célèbre débat eu lieu entre Samuelson [1975] et Deardorff [1976] à propos de la réelle optimalité de la "Goldenest Golden Rule" ("la plus dorée des règles d'or"). La "Goldenest Golden Rule" représente le taux de croissance de la population qui maximise l'utilité sur le sentier de croissance stationnaire. Deardorff affirme que, pour toute spécification du modèle où l'utilité et la production respectent les propriétés de la Cobb-Douglas, la plus dorée règle d'or de Samuelson consiste, en fait, en un minimum global et non un maximum. Puisque la fécondité n'est pas traitée comme un choix rationnel, cette littérature n'est pas capable d'expliquer pourquoi la fécondité courante n'égalise pas la fécondité optimale. De plus, comme les déterminants de la fécondité ne sont pas déterminés, aucune recommandation de politique économique ne peut être faite.

Si le modèle Beckerien permet d'investir la question de l'optimalité des comportements de fécondité, il nécessite de raffiner le concept usuel d'optimalité. Deux contributions récentes de Golosov et al [2007] et Michel & Wigniolle [2007] redéfinissent la Pareto optimalité lorsque la fécondité est endogène. Ils affirment que le critère usuel doit être enrichi notamment parce que pour définir le meilleur des équilibres, il est nécessaire de comparer l'utilité qui est effectivement distribuée avec celle qui aurait pu être distribuée à un nombre d'agents différents. Par exemple, comme le soulignent Golosov et al [2007], la valorisation des agents qui auraient pu naitre mais qui ne sont pas nés doit être considérée pour déterminer la Pareto efficacité d'un équilibre: si certains agents auraient pu naitre sans diminuer l'utilité des agents déjà nés, l'allocation n'est pas optimale.

Quel est alors un bon objectif de bien-être social?

Lorsque le planificateur social peut choisir la taille de la population, répondre à cette

question n'est pas neutre pour les résultats d'un modèle. Par exemple, maximiser l'utilité totale distribuée dans l'économie (utilité sociale de type Benthamienne) peut amener à un résultat très différent que de maximiser l'utilité de la famille représentative (fonction d'utilité sociale de type Millienne). En effet, lorsque la fonction d'utilité Benthamienne est retenue, le planificateur social a une plus forte préférence pour la fécondité que lorsque la représentation Millienne prévaut. Nerlove et al [1986] étudient l'optimalité des comportements de fécondité dans un cadre où les parents valorisent à la fois le nombre de leurs enfants et la consommation qu'ils allouent à ces derniers. Ils montrent qu'à l'optimum de premier rang, la fécondité est supérieure lorsque que le planificateur est Benthamien que lorsqu'il est Millien.

Blackorby et al [2006] soulignent les limites de l'approche Benthamienne et de l'approche Millienne. D'un côté, ils montrent que maximiser l'utilité totale peut mener à la "solution répugnante" dans laquelle la taille de la population est maximale et le bien-être moyen proche de zéro[9]. De l'autre côté, maximiser l'utilité moyenne implique que l'ajout, toute chose égale par ailleurs, d'un individu avec une très faible utilité sur l'ensemble de sa vie (même en deçà de la neutralité[10]) est désirable tant que la population existante bénéficie d'une utilité moyenne encore plus faible. Pour pallier ces faiblesses, Blackorby et al [2005] explorent le concept du niveau d'utilité critique qui, s'il peut être attribué à un nouvel individu sans réduire l'utilité de la population existante, mène à une alternative qui est aussi bonne que si ce nouvel individu n'était pas ajouté à la population.

De même, sachant que la fécondité est plus forte dans les familles les plus pauvres, si le planificateur social est Rawlsien (critère Maximin), le taux de fécondité optimal est plus fort que si le planificateur est Millien. Par exemple, Spiegel [1993] étend le cadre de Nerlove et al [1986] à un planificateur Rawlsien. Il montre que, malgré l'objectif Maximin, la fécondité à l'équilibre de laissez-faire peut être supérieure à la fécondité optimale.

Après avoir précisé les concepts d'optimalité et de bien-être social, la littérature à ex-

[9]<footnote>Ils posent qu'un principe de population implique la solution répugnante si toute alternative dans laquelle tous les agents bénéficient d'un niveau d'utilité supérieur à la neutralité est classé comme aussi mauvais qu'une alternative dans laquelle chaque membre d'une plus grande population a un niveau d'utilité supérieur à la neutralité mais qui peut être arbitrairement proche de cette dernière.

[10]Blackorby *et al* [2006] précisent qu'une utilité sur l'ensemble de la période de vie égale à zéro représente la neutralité. Au delà de la neutralité, une vie vaut la peine d'être vécue, en dessous elle ne mérite pas d'être vécue.Du point de vue d'un individu, une vie neutre est une vie qui mérite autant d'être vécue que de ne pas l'être.

ploré les raisons pour lesquelles les comportements individuels de fécondité ne mènent pas à l'optimum social.

1.2 Les Raisons de l'Inoptimalité

Un comportement économique s'avère inoptimal soit parce qu'il existe une imperfection sur le marché où le bien est échangé, soit parce que ce bien est une source d'externalités. De par sa nature, la quantité d'enfants ne peut être échangée sur un marché[11]. On peut, dès lors, raisonnablement supposer que l'inoptimalité des comportements de fécondité ne provient que d'externalités. De telles externalités sont nombreuses. La fécondité peut être, d'une part, source d'externalités négatives car elle: (i) desserre la contrainte de budget des systèmes de retraite par répartition. Groezen et al [2003] et Loupias & Wigniolle [2004] montrent que la production marginale des enfants financera le système (ii) accroît le pouvoir géopolitique et militaire du groupe (une nation ou un groupe au sein d'une population). Dans leur article consacré à la catastrophe de l'Ile de Pâques, De la Croix & Dottori [2008] supposent que, dans la quête du pouvoir de négociation le plus élevé, le plus gros groupe a la plus grande probabilité de gagner la guerre (iii) rend plus probable l'émergence d'innovations (voire, par exemple, Jones [1999]).

La fécondité peut être, d'autre part, une source d'externalités négatives car, par exemple: (i) elle intensifie l'exploitation des ressources non renouvelables, ce qui pose la question du développement soutenable (voire D'Alessandro [2007], d'Albis & Ambec [2008]). De la Croix & Dottori [2008] affirment que, si une plus forte fécondité accroît le pouvoir du groupe dans l'optique d'une guerre, ce phénomène peut mener à une course au peuplement incitant les groupes à continuellement accroitre leur taille. Dès lors, une surpopulation et une surexploitation des ressources peuvent apparaitre et mener à l'effondrement du système. (ii) elle accroît la probabilité de d'épidémie (voire par exemple Dasgupta [1993]) (iii) elle crée des problèmes de passager clandestin dans les communauté où élever un enfant est bon marché (par exemple en présence de travail des enfants) et où les ressources locales sont

[11] De la Croix & Gosseries [2008] proposent un modèle où, pour atteindre le taux de fécondité national optimal, un marché de droits à procréer (ou de dispense de procréation) est implementé. Dans ce cas, la quantité d'enfants devient un bien échangeable. Cependant, l'inoptimalité des comportements de fécondité ne peut pas venir d'imperfections sur ce marché qui assurent la décentralisation du taux de fécondité national optimal.

détenues par la communauté (faible définition des droits de propriétés). Dasgupta [2000] fournit de nombreuses illustrations de cette externalité dans les pays pauvres.

1.3 Contribution du Chapitre

S'il existe une large littérature explorant les externalités provenant des comportements de fécondité, il est surprenant de constater qu'il n'existe aucune étude explorant les propriétés d'optimalité de l'arbitrage entre qualité et quantité dans le modèle Beckerien de base. On pourrait arguer que déterminer les recommandations de politique économique de ce cadre basique est inutile car le manque de réalisme de ce dernier empêche de formuler des recommandations crédibles. Il est vrai que les nombreux raffinements du cadre Beckerien permettent d'investir des problèmes qui s'avèrent bien en dehors du cadre du modèle Beckerien standard. La littérature traitant de ces raffinements peut être divisée en deux groupes: les modèles incluant la fécondité sans prendre en compte la qualité[12] et les modèles qui endogénéise l'arbitrage qualité-quantité. Les modèles n'incluant que l'aspect quantité s'avèrent relativement incomplets. En effet, à cause de la non linéarité de la contrainte de budget parentale, rien n'assure qu'une "politique optimale" taxant ou subventionnant le revenu parental ou les naissances, dans les modèles sans qualité, ne distordent pas de manière inoptimal les investissements parentaux dans l'éducation et la santé des enfants. Les résultats de ces modèles sont affaiblis.

Balestrino et al [2000], Cigno & Pettini [2002], Nerlove et al [1986] and Spiegel [1993] explorent les politiques familiales optimales avec arbitrage qualité quantité endogène, leurs cadres ne s'avèrent toutefois pas suffisamment généraux. Balestrino et al [2000] and Cigno & Pettini [2002] s'intéressent à des problèmes spécifiques de taxation optimale du revenu en présence de problèmes de passager clandestin et d'hétérogénéité dans les capacités des parents à élever leurs enfants. Nerlove et al [1986] and Spiegel [1993] se placent dans un cadre finalement statique où les parents ne vivent que deux périodes et les enfants une seule.

Etudier les implications du modèle Beckerien de base permet de clarifier les conclusions de la littérature économique explorant l'optimalité des comportements de fécondité. Le premier chapitre de cette thèse fournit cette étude et montre à la fois que les résultats des modèles

[12] Voire, par exemple, Fraser [2001] and Ab et al [2004].

sans qualité peuvent être contrariés et que la non linéarité fondamentale de ce modèle aboutit à des recommandations de politique économique non intuitives.

J'affirme, dans ce chapitre, qu'il existe un consensus dans la littérature économique et au sein des institutions internationales sur la légitimité des politiques d'éducation. Cette légitimité tient au fait que l'éducation est une source d'externalités positives. Je démontre, dans le cadre Beckerien standard[13], que l'éducation doit effectivement être subventionnée car elle est source d'externalités positives mais que toute subvention de l'éducation nécessite d'implémenter une politique complémentaire de subvention ou de taxation des naissances même si ces dernières ne sont pas source d'externalités. Cette politique consistera en une taxation des naissances pour un grand nombre de fonctions de bien-être social, par exemple, les fonctions Milliennes et Benthamiennes peuvent mener à ce résultat.

La nécessité de subventionner ou taxer les naissances en compléments des politiques d'éducation provient de la non linéarité de la contrainte de budget familiale. En effet, pour toute fonction de bien-être sociale, les parents n'investissent pas assez dans l'éducation de leurs enfants à l'équilibre de laissez-faire. Il s'ensuit que les dépenses d'éducation doivent être subventionnées. Supposons qu'il n'existe aucune externalité de fécondité, que tous les comportements soient observables et que le planificateur social cherche à maximiser l'utilité de la famille représentative[14], la seule imperfection éloignant l'équilibre de laissez-faire de l'optimum social réside dans l'externalité d'éducation. Il semble alors intuitif que la subvention des dépenses d'éducation financée par un transfert forfaitaire devrait suffire à décentraliser l'optimum de premier rang. Je démontre que cette intuition n'est pas bonne car la non linéarité de la contrainte budgétaire familiale implique que la subvention des dépenses d'éducation réduit le coût total de la quantité d'enfants. Dès lors, lorsque la subvention à l'éducation est implémentée, les parents choisissent un trop fort taux de fécondité. Il est alors nécessaire de taxer les naissances pour décentraliser l'optimum social. Lorsque l'hypothèse de planificateur Millien est relâchée, il est possible que le planificateur social ait une plus

[13]Le cadre Beckerien standard est défini dans les sous-sections précédentes. Les parents valorisent leur consommation de commodités, le nombre de leurs enfants et le capital humain qu'ils fournissent à ces derniers. Leur contrainte de budget n'est pas linéaire: les coûts de la qualité et de la quantité dépendent des choix de qualité et de quantité.

[14]Ceci assure que le planificateur ne valorise pas plus la fécondité que les familles. Si l'on avait choisit un planificateur Benthamien, ce dernier aurait eu un gout pour la fécondité plus prononcé que celui des familles.

forte préférence pour la quantité d'enfants que les familles[15], ceci est vérifié dans le cadre d'un planificateur Benthamien. Je démontre alors, que subventionner les naissances en complément de subventions à l'éducation sera une politique optimale lorsque la distance entre préférences sociales et préférences individuelles dépasse un certain seuil.

Dans une extension de ce modèle, la mortalité infantile[16] est endogénéisée: les parents peuvent investir dans la santé de leurs enfants. Pour déterminer leur arbitrage optimal entre qualité et quantité, les parents doivent maintenant déterminer leurs nombre d'enfants, l'investissement qu'ils consentent pour limiter le nombre d'enfants qui ne survivront pas à l'âge de cinq ans et l'éducation des enfants survivants. Dans ce cadre, les dépenses parentales de santé constituent une autre source d'externalités: le niveau de santé moyen détermine la probabilité d'épidémie dans la population (voire, par exemple, Dasgupta [1993]). Je montre alors que, malgré le fait que les parents n'investissent jamais assez dans la santé de leurs enfants à l'équilibre de laissez-faire, les dépenses individuelles de santé doivent être parfois taxées. En effet, je démontre, comme dans le cas précédent, que les dépenses d'éducation doivent être subventionnées et les naissances taxées[17]. La taxation des naissances joue alors le rôle d'une subvention indirecte aux dépenses de santé: pour un atteindre le même nombre d'enfants survivants, il devient avantageux d'accroître ses dépenses de santé et de réduire le nombre d'enfants mis au monde. Dès lors, si la taxation des naissances est très forte, les dépenses de santé peuvent devenir trop importantes et doivent être taxées. Je montre particulièrement que la subvention des dépenses de santé aura d'autant plus de chance d'être positive que les externalités d'éducation sont faibles relativement aux externalités de santé.

Ce premier chapitre montre finalement que le cadre Beckerien standard fournit des recommandations de politique économiques qui ne s'avèrent pas intuitives. Il est alors clair que les conclusions des modèles de fécondité n'incluant pas la qualité, au moins dans sa dimension la plus simple de capital humain, sont affaiblies par ce résultat. Représenter la qualité des enfants par leur futur capital humain a également été privilégié par la littérature analysant la transition démographique. Il apparait dans cette dernière que le modèle Beckerien est un

[15] Les raisons de l'écart entre préférences sociales et préférences individuelles pour la quantité d'enfant peuvent être nombreuses et provenir soit de la fonction de l'objectif de bien-être social même ou d'externalités. Les exemples d'externalité précédemment cités peuvent en partie s'appliquer ici.

[16] La mortalité infantile est ici entendue comme le risque de décès d'un enfant avant l'âge de cinq ans.

[17] Cette extension ne se limite qu'au cas Millien où les naissances doivent être taxées.

outil très performant pour expliquer les grands faits stylisés de cette transition mais qu'il s'avère limité pour intégrer la dimension culturelle du phénomène.

2 Second Chapitre: La Transmission Culturelle comme Facteur de la Transition Démographique

Une large majorité de pays a déjà expérimenté la transition démographique. De plus, les démographes anticipent que l'Humanité toute entière aura achevé ce processus à l fin du siècle. La transition démographique peut être simplement définie par la transition d'un régime de haute mortalité et haute fécondité à un régime de basse mortalité et de basse fécondité. Le décalage temporel souvent constaté entre la baisse de la mortalité et celle de la fécondité donne lieu à une accélération temporaire de la croissance démographique. En Europe Occidentale comme dans le reste du monde, le taux de croissance annuel moyen de la population mondiale était proche de 0,1% entre l'an zéro et 1820 (Maddison [2003]). Lorsque l'Europe de l'Ouest et les Etats-Unis sont entrés dans leur transition, ce taux de croissance annuel moyen a augmenté jusque 0,8% entre 1870 et 1913. L'entrée tardive, dans le processus, des pays moins développés a accru ce taux jusque 1,92% entre 1950 et 1973. L'Europe de l'Ouest a entamé sa transition démographique au début du 19è siècle. L'Angleterre et la France ont été les premiers pays à réduire leur taux de fécondité à long terme.

Les économistes proposent des modèles de croissance qui permettent à la fois de reproduire les faits stylisés de la transition démographique et de la Révolution Industrielle.

2.1 Les Analyses Traditionnelles de la Transition Démographique

Les démographes ont longtemps avancé que la chute de la mortalité et surtout de la mortalité infantile a été le principal facteur de la baisse de la fécondité à long terme[18]. Les progrès majeurs dans le domaine de l'hygiène et de la stérilisation ont permis une réduction de la mortalité infantile. Dès lors, les parents ont eu besoin de mettre moins d'enfants au monde pour avoir le même nombre d'enfant survivants qu'auparavant. Le décalage temporel

[18] Des économistes ont également exploré ce mécanisme. Voire, par exemple, Kalemli-Ozcan [2003] and Eckstein et al [1999].

entre baisse de la mortalité et baisse de la fécondité[19] est alors présenté comme une adaptation progressive des comportements de reproductions à la chute de la mortalité (voire, par exemple, Henry [1976]).

Cette explication s'avère cependant contrefactuelle. Par exemple, Fernandez-Vilaverde [2004] montre, au cours d'une analyse quantitative, que le recul de la mortalité n'est pas significatif pour expliquer la chute de la fécondité pendant la transition démographique. Doepke [2005] montre également que la baisse de la mortalité infantile n'est pas responsable de la baisse de la fécondité nette pendant la transition démographique anglaise entre 1861 et 1951. De plus, les transitions démographiques française et américaine font office de contre-exemple, dans ces deux pays, la fécondité a commencé à décroitre avant la fécondité.

Becker [1981] affirme que la baisse des taux de fécondité a été provoquée par l'accroissement des revenus lors de la Révolution Industrielle. Galor & Weil [1996] proposent un modèle où le progrès technique qui caractérise la Révolution Industrielle réduit l'écart de salaires entre hommes et femmes.car il réduit ma complémentarité entre capital et force physique. Il accroît le coût de la quantité (principalement supporté par les femmes[20]) relativement à celui de la qualité. Les parents tendent donc à avoir moins d'enfants auxquels ils fournissent plus d'éducation.

Galor & Weil [1999] proposent un modèle qui donnera naissance à la théorie de la croissance unifiée[21]. Ils y expliquent l'émergence de la Révolution Industrielle et de la transition démographique par un accroissement du progrès technique. Cette accélération du progrès technique provient d'effets d'échelle: une croissance larvée de la population fait naître un progrès technique faible. Ce progrès technique accroît le revenu des parents et les rende-

[19] Une fois que la fécondité a convergé vers sa faible valeur de long terme, la croissance de la population restera élevée durant plusieures périodes. Ce phénomène est nommé la momentum de la population. Il se définit comme la tendance de la croissance de la population à rester élevée au delà du moment où la fécondité a atteint son niveau de remplacement à cause de la forte concentration d'agents en age de procréer.

[20] Galor & Weil utilisent un modèle unitaire, c'est à dire un modèle où la couple agît finalement comme un seul agent. La littérature traitant des modèles de décision familiale a propsé une alternative à cette représentation: le modèle collectif (voire Browning *et al* [???] pour une revue de cette littérature). Dans ce cadre, le comportement du ménage résulte de la négociation entre ses membres. En d'autres termes, le ménage ne se comporte plus comme un planificateur ienveillant . Cette littérature a enrichi certains résultats fondamentaux du modèle Beckerien. Il montre notamment que le revenu de la femme influence négativement la fécondité du ménage alors que le salaire de l'hmme a un impact positif (voire, par exemple, De la Croix & Vander Donckt [2008]).

[21] Galor [2005a] proposent une revue de cette littérature.

ments de l'investissement dans le capital humain des enfants. Initialement, les rendements de l'investissement en capital humain et les revenus parentaux ne sont pas suffisants pour inciter les parents à investir dans l'éducation de leurs enfants. Les parents accroissent donc leur fécondité à la suite de la hausse du revenu (effet de revenu positif). Lorsque le progrès technique a atteint un certain seuil, l'investissement éducatif devient profitable et les parents substituent de la qualité à la quantité lorsque le revenu augmente suite au progrès technique. Dès lors, le capital humain moyen s'accroit, un progrès technique endogène voit le jour et pousse l'économie sur un sentier de croissance de long terme où la fécondité converge vers un taux de fécondité stationnaire bas.

Une vaste littérature a complété cette approche fondamentale de Galor & Weil [1999]. Elle explore des mécanismes renforçant les conclusions de Galor et Weil. Parmi ces mécanismes, on peut citer: (*i*) l'accroissement de l'écart de salaires entre enfants et adultes lié au progrès technique qui accroit les rendements de l'investissement éducatif (voire Hazan & Berdugo [2002]), (*ii*) la hausse de l'espérance de vie qui accroit également l'espérance de vie[22], (*iii*) l'hypothèse d'assurance pour les vieux jours (voire Ehrlich & Lui [1991]) et (*iv*) la chance, le hasard (voire Becker et al [1990]).

De la Croix & Doepke [2003] proposent un modèle où le différentiel de fécondité entre riches et pauvres influence la relation entre inégalités et croissance. Ils montrent que de plus fortes inégalités entre riches et pauvres ralentissent la croissance et le développement car les agents pauvres ont une plus forte fécondité que les riches et investissent moins dans l'éducation de leurs enfants. Leur proportion dans la population s'accroit donc et le capital humain moyen se réduit. Finalement, de plus fortes inégalités retardent la transition démographique et ralentit la croissance.

Si toutes ces contributions fournissent des explications consistantes de la transition démographique, elles ne peuvent prendre en compte un déterminant majeur de la baisse de la fécondité à long terme: les interactions entre les déterminants économiques et culturels de la fécondité. Le rôle des facteurs culturels dans la transition démographique en Europe de l'ouest a été très largement documenté par les démographes, les sociologues et les anthropologues[23]. Par exemple, les démographes du Projet de Princeton (voire Coale &

[22] Voire, par exemple, Hazan and Zoabi [2005], Moav [2005].

[23] Les démographes anthropologues montrent que l'évolution de la distribution des traits génétiques ou

Watkins [1986]) montrent que la transition démographique en Europe de l'Ouest résulte de l'interaction entre une transition économique et une transition culturelle. Une telle transition culturelle a rendu le contrôle des naissances acceptable. Lesthaeghe [1986] fournit également des faits empiriques montrant que l'évolution du Catholicisme a été décisive dans la décroissance de long terme de la fécondité en Europe de l'Ouest.

En étudiant le cas de l'Afrique Sub-saharienne, Dasgupta [2000] affirme que la conformité envers les valeurs culturelles ancestrales explique en partie la persistance de forts taux de fécondité. Il précise notamment que la procréation n'est pas qu'un acte privé, c'est également un acte social influencé par l'expérience familiale et le milieu culturel.

A la suite de Knodel [1988], une vaste littérature propose des études restreintes au niveau d'un pays voire même de très petites zones géographiques[24] (régions ou villages) afin d'isoler les facteurs culturels (voire par exemple, Assve et Altankhuyag [2006] and Zachariah [2006]).

L'existence de toutes ces études constitue une incitation à proposer un modèle où l'interaction entre dynamiques culturelles et économiques explique la transition démographique. modéliser cette interaction exige de renoncer à l'hypothèse de préférences stables et exogènes.

2.2 Contribution du Chapitre

Ce chapitre vise à proposer un modèle de fécondité où l'interaction entre déterminants économiques et culturels de la fécondité explique la transition démographique. Il est utile, pour ce faire, de rendre endogènes les préférences et leur transmission Utiliser des préférences endogènes et non constantes n'est pas usuel pour les économistes; une littérature récente propose des cadres d'analyse y parvenant sans tomber sous la critique de Becker & Stigler [1977]. On peut citer, entre autres, l'endogénéisation des normes sociales[25], l'investissement parental dans la patience des enfants[26] et les approches évolutionnaires[27].

culturels peut expliquer la transition démographique. Voire, par exemple, Bergstrom & Stark [1993] et Fricke [1997].

[24] Hammel [1990] et Mason [1997] critiquent la localisation croissante des études de la transition démographique par les démographes. Ils affirment que la forte localisation de ces études empêchent la validation d'une théorie générale de la transition démographique.

[25] Voire, par exemple, Duesenberry [1949], Blomquist [1993], Lindbeck [1995], Lindbeck *et al* [1999] and Palivos [2001].

[26] Voire Doepke & Zilibotti [2008].

[27] Bergstrom [1996] fournit une revue de cette littérature.

Galor & Moav [2002] fournissent une contribution majeure aux explications évolutionnaires de la baisse à long terme de la fécondité. Galor & Weil assument l'existence de groupes "génétiquement" différents: les agents orientés vers la qualité et les agents orientés vers la quantité[28]. La transmission des préférences (type génétique) des parents vers les enfants est parfaite. A l'échelle de la population, le différentiel de fécondité entre les groupes régit l'évolution des préférences: le groupe avec la fécondité la plus élevée devient majoritaire et influence fortement les préférences moyennes.

Inclure des processus évolutionnaires permet de relâcher l'hypothèse de préférences stables et exogènes. En effet, l'interaction entre conditions économiques et évolutionnaires explique les changements à long terme du goût pour la quantité d'enfants. Une limite de cette explication évolutionnaire tient au fait que seule le différentiel de fécondité entre les groupes compte pour expliquer l'évolution de long terme des préférences. Ceci empêche de décrire le rôle de la culture, des normes sociales et des institutions dans la transition démographique.

Bisin & Verdier [2001] proposent un modèle endogénéisant la transmission culturelle et la dynamique des préférences. Ils affirment que la transmission des préférences des parents vers les enfants n'est pas parfaite car elle est culturelle plutôt que génétique. Les parents doivent fournir un effort pour transmettre leurs préférences à leurs enfants. S'ils échouent, leurs enfants seront directement socialisés par la société. L'évolution des préférences est alors endogène, elle résulte de l'interaction entre comportements économiques et culturels des agents et de la composition culturelle de la population.

Ce second chapitre utilise un cadre à la Bisin & Verdier pour élaborer un modèle de fécondité à générations imbriquées où les interactions entre facteurs culturels et économiques expliquent la baisse de la fécondité à long terme. Je suppose l'existence de deux cultures. la première culture est dite "Traditionnelle". Les Traditionnels suivent une norme de fécondité élevée et adoptent un mode de production rural agricole. La seconde culture est dite "Moderne", ses membres ne suivent aucune norme de fécondité[29] et adoptent un mode de production industriel. Chaque agent, arrivé à l'âge adulte, doit déterminer sa consom-

[28] Cette hypothèse est élégamment justifiée dans l'article de Galor & Moav.

[29] Cette hypothèse trouve des points communs avec celle de Galor & Moav [2002]. Je fournis cependant, dans ce chapitre, une justification culturelle plutôt que génétique. Je me concentre principalement sur la religion.

mation de commodités, le nombre d'enfants qu'il met au monde et l'effort de socialisation qu'il fournira pour transmettre sa culture à ses enfants. Parce que les parents choisissent rationnellement leur effort de socialisation, la composition culturelle de la population dépend crucialement des conditions économiques en vigueur tel que le coût d'élever un enfant, le revenu parental et le différentiel de productivité entre les modes de production.

Dans ce cadre, un choc de productivité en faveur du mode de production industriel produit un "effet évolutionnaire" en faveur des Traditionnels" et un "effet culturel" en faveur des Modernes. En effet, un tel choc accroît l'écart de richesse entre Modernes et Traditionnels. La déviation culturelle[30] devient plus acceptable pour les Traditionnels car leurs enfants bénéficieront de revenus plus élevés s'ils adoptent la culture moderne. En conséquence, les Traditionnels réduisent leur effort de socialisation. Ils accroissent dans le même temps leur fécondité car l'utilité espérée par enfant augmente. L'inverse est vrai pour les Modernes: un accroissement de leur revenu relatif rend la déviation culturelle de leurs enfants plus couteuse en terme d'utilité. Ils accroissent donc leur effort de socialisation et comme les enfants sont intensifs en temps, ils réduisent leur fécondité. Dès lors, comme les Traditionnels accroissent leur fécondité alors que les Modernes réduisent la leur, la proportion de Traditionnels dans la population tends à croitre: ceci est appelé l'effet évolutionnaire. Cependant, comme les Modernes accroissent leur effort de socialisation alors que les Traditionnels réduisent le leur, la proportion de modernes tend à augmenter dans la population: ceci est appelé effet culturel.

Les interactions entre effets culturels et évolutionnaires impliquent trois résultats essentiels. Premièrement un choc technologique asymétrique en faveur du secteur industriel provoquera une transition démographique uniquement s'il est accompagné par un transition culturelle donnant la majorité aux Modernes. En d'autres termes, le progrès technique asymétrique doit être suffisamment soutenu pour faire diminuer la fécondité des Modernes et provoquer une transition culturelle où les Traditionalistes dévient massivement vers la culture Moderne. Deuxièmement, si les Traditionnels sont fortement attachés à la perpétuation de leur culture, ils maintiendront des efforts de socialisation élevés en dépit du progrès technologique asymétrique[31]: l'effet culturel est faible relativement à l'effet évolutionnaire.

[30] Une déviation culturelle se produit lorsqu'un enfant adopte une culture différente de celle de son parent.

[31] J'assume que faisant face au progrès technique en faveur du mode de production industriel des Modernes,

Dès lors, les transitions culturelle et démographique apparaîtront plus tard, pour un écart technologique plus important entre les secteurs de production. Une fois enclenchée, la transition démographique sera plus rapide car les Modernes deviendront majoritaires au moment où leurs taux de fécondité seront déjà très faibles. Il est important de noter que le progrès technique asymétrique peut provoquer une hausse initiale de la part des Tradionalistes dans la population et un accroissement temporaire du taux de fécondité moyen[32]. Troisièmement, dans un environnement où le mode de production industriel est initialement faiblement productif et ne bénéficie pas d'un progrès technique suffisamment rapide, la culture Moderne peut disparaitre à long terme. A l'inverse, si le progrès technique asymétrique en faveur de l'industrie est fort, la culture Traditionnelle peut disparaitre à long terme. En effet, comme la transmission des préférences n'est pas parfaite car culturelle plutôt que génétique, la mobilité entre les groupes peut conduire à la disparition de l'un d'entre eux: lorsque les traits culturels d'un groupe sont trop fortement inefficaces sur le plan économique, ses membres finissent par ne plus essayer de transmettre leur culture à leurs enfants. Il est important de noter que le progrès technique asymétrique en faveur de l'industrie n'a pas besoin d'être permanent pout que la culture Traditionnelle disparaisse. Il a uniquement à maintenir un écart de revenus suffisant entre les deux modes de production pendant une période de temps limitée. En effet, la disparition d'une culture étant un phénomène irréversible, une fois que l'un des groupes a disparu, l'arrêt du progrès technique asymétrique ne suffira pas à faire ré-augmenter la part des Traditionnels. (PARTIE A RETOUCHER)

Ce chapitre propose donc un modèle simple qui permet de reproduire un certain nombre de faits stylisés de la transition démographique en Europe de l'Ouest. En effet, l'étude de la transition démographique en Europe de l'Ouest par les démographes et les Historiens montrent que l'apparition de la transition démographique a été fortement liée à l'urbanisation, l'industrialisation et la sécularisation définie comme un processus retirant aux autorités religieuses certains aspects de la vie sociale et culturelle. Ces travaux montrent que la réduction à long terme de la fécondité est le fruit de la mutation de l'environnement économique et

les Traditionnels n'abandonne pas leur mode de production dont l'efficacité relative décroît. La persistance de comportemetns économiques inefficaces est reportée et expliquée dans bon nombre d'études tel que Salamon [1992], Grusec & Kuckzynski [1997] et Guiso *et al* [2006].

[32]La hausse temporaire de la fécondité au début de la Révolution industrielle est un fait stylisé reporté, par exemple, par Galor [2005a & b], Madison [????], etc.

social et de la sécularisation. Cette dernière a été une condition nécessaire à la transition démographique

Dans ce chapitre, les Traditionalistes peuvent être identifiés comme Catholiques et Calvinistes. En accord avec leur culture, ils essaient de respecter une norme de fécondité élevée et prennent part à un mode de production familial agricole. Les Modernes ne sont pas influencés par les institutions religieuses, leurs choix de fécondité ne sont pas déterminés par une norme explicite et ils prennent par au secteur industriel (ils sont sécularisés). Une partie du chapitre est dédiée à la discussion de ces hypothèses. De nombreuses illustrations empiriques sont apportées pour l'Europe de l'Ouest à la veille et pendant la Révolution Industrielle[33]. La sécularisation de la population est alors représentée par la baisse à long terme de la proportion de Traditionnels. En effet, cette baisse correspond à un recul de l'influence des normes religieuses à l'échelle de la société. Lorsque le progrès technique asymétrique est suffisamment fort[34], la population entame sa sécularisation et sa transition démographique. La survenance de ce processus est conditionnel à l'intolérance des Traditionnels[35]. Si cette intolérance, résultant en partie de la doctrine de l'Eglise, est forte, la population entre plus tard en sécularisation et en transition démographique. La baisse de sa fécondité sera alors plus tardive mais plus rapide[36].

Au delà des travaux des démographes, des historiens et des sociologues, la prise en compte de variables culturelles dans l'explication de la dynamique des population trouve également ses fondements dans une littérature empirique récente. Les économistes ont récemment bénéficié de bases de données suffisamment riches pour étudier l'impact des variables culturelles et, spécialement religieuses, sur les comportements de fécondité dans un cadre où les conclusions Beckerienne peuvent également être testées. Le troisième chapitre de cette thèse fournit une contribution à cette littérature en étudiant le cas de la France.

[33] Voire par exemple, Lesthaeghe & Wilson [1986], Lesthaeghe [1977], Van Poppel [1985], Van Bavel & Kok [2005], Neven & Oris [2003], etc.

[34] Le biais industriel du progrès technique durant la Révolution Industrielle est fortement documenté. Voire, par exemple, Bairoch [1997].

[35] L'intolérance se comprend ici comme l'attachement d'un agent, toute chose égale par ailleurs, à la perpétuation de sa culture dans sa propre dynastie. Dans ce chapitre, les Modernes font preuve d'intolérance au même titre que les Traditionnels.

[36] Voire, par exemple, Van Heek [1956] pour la Hollande et Lesthaeghe [1977] pour la Belgique.

3 Troisième Chapitre: Religion et Fécondité, le Cas Français

3.1 Une très brève revue de la littérature

Les économistes ont récemment entamé une étude de l'impact de la culture et des normes sociales sur les comportements économiques. Grace au développement de bases de données incluant un grand nombre de proxies pour la culture, ils sont à même de discriminer entre variables culturelles et non culturelles ainsi que de tester la causalité entre culture et comportements économiques[37].

Fernandez & Fogli [2007] ont fourni une contribution majeure à l'étude du lien entre comportements de fécondité et variables culturelles. Ils parviennent à approximer la culture par des variables purement économique. Ils montrent, pour les Etats-Unis aux 20ème siècle, que la culture nationale des immigrants a un impact significatif sur leur fécondité et leur participation au marché du travail. Ils approximent la norme culturelle des immigrants vis à vis de la fécondité et de la participation au marché du travail par le taux de fécondité moyen et la participation moyenne des femmes au marché du travail dans le pays d'origine (approche épidémiologique). Ils trouvent que, toute chose égale par ailleurs, le taux de fécondité moyen du pays d'origine a un impact positif et significatif sur la fécondité des immigrants.

La littérature a également privilégié une autre méthode pour mesurer l'impact de la culture sur les comportements de fécondité. Cette méthode approxime la culture par des variables religieuses. Cette méthode est depuis longtemps utilisée par les démographes et les sociologues. Les économistes n'y ont pas réellement eu recours parce que les bases de données disponibles ne contenaient pas suffisamment de variables économiques satisfaisantes. L'économétrie moderne indique clairement que mesurer l'impact de variables culturelles en omettant les variables économiques fondamentales conduirait à des résultats non valides. Cependant, les bases de données récentes incluent de manière satisfaisante des données religieuses et économiques. Par exemple, Adserá [2006] et Branas-Garza & Neuman [2006] montrent qu'après avoir contrôlé par les déterminants économiques usuels, l'intensité de la pratique religieuse a un impact positif et significatif sur la fécondité[38].

[37] Guiso *et al* [2006] fournissent une revue de cette littérature.

[38] Une revue de cette littérature est fournie dans le chapitre.

3.2 Contribution du Chapitre

Le troisième chapitre de ma thèse fournit une contribution à la littérature récente qui explore l'impact de la religion et de la transmission culturelle sur les comportements de fécondité dans un cadre où les effets Beckeriens standards peuvent être contrôlés. La base de données "Enquête Mode de Vie des Français" constitue la première occasion de mesurer l'impact de la religion et de la religiosité sur les comportements de fécondité en France. En effet, la loi française rend très difficile la collecte et l'exploitation de données religieuses.

La base "Enquête Mode de Vie des Français" fournit des variables religieuses précises tel que la religion d'origine, la croyance, la fréquence à laquelle les répondants assistent aux offices religieux et l'estimation par les agents de l'importance de la religion dans leur propre vie. La richesse de l'enquête ne se limite pas aux variables religieuses, sont également disponibles des informations sur la situation économique du répondant (revenus, épargne, richesse, parcours sur le marché du travail...), son mode de vie (santé, addictions, habitudes de consommation...), son attitude face au risque et ses valeurs (religion, politique, attitude face aux étrangers, valeurs familiales...).

A l'aide de régressions de Poisson, je montre que les seules variables religieuses qui ont un impact sur la fécondité sont celles mesurant le degré de pratique qui est mesuré de deux manières, la religion d'origine et la croyance n'ont pas d'impact significatifs. La première mesure de la religiosité est usuelle dans la littérature, elle correspond à la fréquence à laquelle le répondant assiste aux offices religieux. Il apparaît que la fécondité d'une femme assistant souvent aux offices religieux (1 fois par semaine) est 24% plus élevée que la fécondité d'une femme n'assistant jamais aux offices. La seconde mesure de la religiosité de l'agent correspond à son estimation, sur une échelle allant de zéro à dix, de l'importance de la religion dans sa vie.

Dans cette étude, l'impact de la culture sur la fécondité ne se limite pas aux variables religieuses. En effet, j'explore deux aspects de la transmission culturelle au sein de la famille: l'influence de la fécondité des parents du répondant et l'impact de la transmission du Sens de la Famille[39] entre générations. Je montre que ces deux canaux de transmission sont aussi im-

[39]La transmission du Sens de la Famille est mesurée par la réponse aux deux questions suivantes: "Parmi les valeurs suivantes, quelles sont les trois premières que vous cherchez ou chercheriez à transmettre à vos enfants?" et "Et quelles sont les trois principales que vos parents ont cherché à vous transmettre?" Parmis les

portants que la religion pour expliquer la fécondité des agents. Avoir grandi dans une famille nombreuse dans laquelle les valeurs familiales sont très importantes accroît significativement la fécondité des agents toute chose égale par ailleurs.

Ces résultats sont contrôlés pour les variables usuelles tel que le statut des agents sur le marché du mariage. Je montre également que les conclusions des modèles Beckeriens sont validées: le revenu de l'homme a un impact positif sur la fécondité de la femme alors que le propre revenu de la femme a un impact négatif. L'éducation de la femme a un impact négatif dans le sens où les femmes les moins éduquées ont moins d'enfants que les autres. L'âge de l'agent est la variable la plus importante pour expliquer la haute fréquence d'observations où le nombre d'enfants est égal à zéro. Ceci traduit le fort ajournement de la première naissance qui est une caractéristique commune à tous les pays développés. Il apparaît également que les femmes les plus éduquées et habitant en zone urbaine sont les plus susceptibles de choisir de ne pas avoir d'enfants.

Un certain nombre de tests montrent que ces résultats sont robustes au changement d'hypothèse sur la distribution[40], à la sélection de l'échantillon[41] et à la stratégie retenue pour mesurer l'effet de l'âge. La correction du biais d'endogénéité pour le revenu de la femme montre à la fois que les effets de revenus restent présents et que les effets culturels en sont indépendants.

4 Conclusion Générale

En analysant la problématique des populations, les économistes tentent de répondre à des questions fondamentales: Existe-t-il une taille optimale pour l'Humanité? Une population jouissant d'un haut niveau de vie est-elle préférable à une plus grande population bénéficiant d'un plus faible niveau de vie? La croissance exponentielle de la population mondiale est-elle

réponses possibles, se trouvaient "La générosité", "La joie de vivre", 'L'honnêteté", "Le sens de la Famille"... Un score allant de zéro à deux est construit, il est croissant avec le nombre de fois où le répondant a choisi "Le Sens de la Famille".

[40] Les résultats sont valides en menant des régressions de type Moindres Carrés Ordinaires et Probit Ordonné.

[41] Les effets culturels et religieux sont toujours vérifiés lorsque l'échantillon retenu correspond aux femmes de plus de 45 ans ainsi qu'à l'ensemble de la population, c'est à dire hommes et femmes sans aucune limite d'âge.

une chance ou une menace pour notre bien-être et notre survie à long terme? Comment peut-on expliquer la baisse historique de la fécondité qui caractérise la transition démographique à laquelle le monde dans son ensemble paraît voué?

Je fournis, dans cette thèse, une contribution aux réponses des économistes à ces questions. Je montre particulièrement deux résultats. Premièrement, lorsque l'on veut traiter de la problématique de la taille optimale des populations à l'aide du cadre Beckérien où la taille des familles est un choix rationel, il est impératif de prendre en compte la "qualité". En effet, dans ce cas, la non linéarité de la contrainte de budget parentale implique que même si la quantité n'est soumise à aucune externalité, la correction des externalités pesant sur les choix d'éducation et de santé ne suffira pas à atteindre la taille optimale de la population. Deuxièmement, je montre que les modèles de fécondité usuels proposés par les économistes ne permettent pas de prendre en compte la dimension culturelle de la transition démographique. Le fait que la transition démographique est le fruit de l'intéraction entre une transition économique et culturelle a été largement mis en évidence par les démographes, les historiens et les sociologues. Je propose donc un modèle de fécondité et de transmission culturelle qui permet de modéliser en partie ce phénomène. Les résultats empiriques que je met en évidence sur données françaises montrent que l'intégration de mécanismes culturels en plus des mécanismes économiques usuels constitue une piste de recherche riche et complexe.

Note de Synthèse

De l'an 1 après Jésus Christ à 2008, la population mondiale est passée de 170 millions d'individus[1] à 6,705 milliards[2]. Cette croissance exponentielle a donné naissance à bon nombre de craintes et de débats à propos de la croissance démographique qui est le plus souvent décrite comme trop forte dans les pays en développement et trop faible dans les pays développés. Mener de tels débats sous-tend l'existence d'un taux de croissance optimal de la population ainsi que d'une taille optimale pour la population mondiale.

Les économistes montrent qu'affirmer l'existence d'une taille optimale de la population soulève des questions complexes. Par exemple, une petite population bénéficiant d'un haut niveau de vie est-elle préférable à une grande population bénéficiant d'un plus faible niveau de vie? La réponse à cette question s'avère profondément liée à la manière dont on évalue la vie d'agents qui auraient pu naître mais qui ne sont finalement pas nés. De plus, si l'on peut parvenir à définir une taille optimale de la population, il faut se demander pourquoi les choix individuels écartent la société de cette situation la plus désirable.

Pour juger du bien-fondé de la croissance démographique que connait notre monde, il est également fondamental de comprendre le lien entre croissance de la population et développement. S'il ne fait aucun doute que de grandes populations

[1] Estimation de US Census Bureau.
[2] Estimation issue du World Population Datasheet 2008.

épuisent plus rapidement les ressources non renouvelables, l'Histoire Economique nous apprend également que l'accroissement de la taille des populations est la cause d'un grand nombre d'avancées dans le monde. En effet, la pression des populations sur les ressources est un moteur de l'innovation qui, en retour, accroît la quantité de ressources disponibles. De plus, les faits empiriques indiquent que le processus de développement n'est pas neutre pour la croissance démographique. Une grande part de l'humanité a connu une transition démographique menant à la réduction, à long terme, de la mortalité et de la fécondité ainsi qu'à une hausse temporaire du taux de croissance de la population. Comprendre les déterminants de ce processus pourrait, par exemple, permettre de déterminer les conditions sous lesquelles les pays en développement achèveront de stabiliser la taille de la population mondiale.

Ma thèse apporte une contribution à l'analyse économique des déterminants de la taille des populations et de l'impact de cette dernière sur le bien-être. Cette thèse se concentre particulièrement sur les comportements de fécondité, facteur majeur de la croissance démographique.

La relation entre science économique et phénomènes démographiques prend racine dans l'analyse économique Classique. Les économistes Classiques ont endogénéisé les variables démographiques dans leur représentation globale de l'économie. Birdsall [1988] divise les Classiques entre pessimistes et optimistes. La plus célèbre théorie pessimiste est celle de Malthus. Dans son "Essaie sur le Principe de Population" [1798], les fluctuations économiques et démographiques sont déterminées par les comportements de reproduction à l'échelle familiale, comportements qui maintiennent l'économie dans une pauvreté perpétuelle. Malthus affirme que lorsque les revenus s'élèvent au dessus de leur niveau de subsistance, les individus, en moyenne, se marient plus tôt et ont plus d'enfants alors même que la mortalité diminue grâce

a une amélioration de l'alimentation. L'accroissement de la population augmente l'offre de travail et la demande de nourriture à la période suivante. Les rendements décroissants du travail et de la terre impliquent que les salaires décroissent alors que les prix de la nourriture augmentent: le revenu tombe en dessous de son niveau de subsistance, les mariages et la fécondité décroissent alors que la mortalité augmente. L'économie en revient finalement à sa situation de long terme où la taille de la population et le niveau de vie sont stables.

Ricardo [1817] propose une analyse relativement proche de celle de Malthus quant à la relation entre dynamiques économique et démographique. Il affirme qu'à long terme, les salaires ne peuvent s'écarter de leur prix naturel. La décroissance des rendements du travail et de la production de céréales rendent inévitable la convergence vers ce prix naturel. Cependant, le pessimisme de Ricardo doit être relativisé car ce dernier propose trois mécanismes pour s'échapper de la trappe de non développement: (*i*) les améliorations de l'agriculture, de l'accumulation du capital, de la division du travail et l'ouverture de nouveaux marchés, (*ii*) l'accroissement du taux de salaire de subsistance qui peut dissocier salaire de subsistance et fécondité élevée (Ricardo précise que la définition du salaire de subsistance est sociale plutôt que biologique), (*iii*) l'apparition du contrôle des naissances qu'il présente comme le moyen ultime pour éradiquer la surabondance démographique.

Tous les économistes Classiques n'ont toutefois pas développé des thèses pessimistes. Dans la Richesse des Nations [1776], Adam Smith affirme que la croissance démographique accélère la croissance économique: une plus grande population accroît la taille du marché, ce qui incite à l'innovation, approfondit la division du travail et finalement améliore la productivité. Marshall [1920], un des fondateurs de l'Economie Néoclassique, affirme également que de plus grandes populations per-

mettent à l'économie de s'amender des rendements décroissants. Il se concentre sur la relation entre santé et force physique et mentale. Il souligne l'importance de l'accroissement du savoir particulièrement dans le domaine de la médecine, savoir qui permettra d'améliorer la santé, réduire la mortalité, améliorer l'efficacité des travailleurs et, finalement, accroître la production. Contrairement à Malthus et Ricardo, Smith et Marshall n'ont pas donné une place centrale à l'interaction entre comportements économiques et démographiques. Ils n'ont, dès lors, pas proposé une théorie optimiste globale sur le lien entre croissance démographique et croissance économique.

Le décollage des économies européennes lors de la Révolution Industrielle a rapidement invalidé les conclusions Malthusiennes et Ricardiennes. En effet, après le début de la Révolution Industrielle (aux alentours de 1820), la corrélation entre croissance de la population et croissance économique est devenue positive[3]. Cet échec peut être considéré comme une des raisons pour lesquelles la révolution marginaliste a d'abord négligé l'analyse des comportements de fécondité. Une autre raison tient probablement au fait qu'appliquer le concept de rationalité à l'analyse des comportements de fécondité dépassait les limites du politiquement correct. Quelqu'en soit la raison, l'économie moderne a débuté son histoire sans appliquer le concept de rationalité à l'analyse des comportements de fécondité. Dès lors, l'opposition entre optimistes et pessimistes est devenue moins visible et la fécondité a été traitée comme une variable exogène.

Même dans leurs modèles de croissance, Solow [1956] et Ramsey [1928] supposent une croissance exogène de la population. Ils la représentent comme un frein à la croissance de la consommation et comme pénalisant le niveau de consommation de long terme. Toutes les extensions de ces cadres d'analyse (par exemple, Lewis [1954],

[3] Voire, par exemple, Galor [2005a, 2005b].

Mankiw *et al* [1992], Lucas [1988], ...) affirment que, toute chose égale par ailleurs, une plus forte croissance de la population implique une plus faible productivité du travail. Pour atteindre le même niveau de capital par tête, il est alors nécessaire d'épargner plus et donc de consommer moins.

Une fois encore, les approches optimistes se concentrent sur les effets d'échelle. Par exemple, Boserup [1965] et Simon [1981] montrent que de plus grandes populations exercent une pression à l'innovation et permettent des économies d'échelle. Contrairement aux modèles de croissance à la Solow-Ramsey, les modèles de croissance endogène affirment que la taille de la population a un effet positif sur la croissance du revenu par tête (voire, par exemple, Aghion & Howitt [1998]). Cet effet taille a été fortement critiqué (voire Amable [2000]), car il est en grande partie contrefactuel. Les contributions de Eicher & Turnovski [1999] et Jones [1999][4] suppriment cet effet taille. Jones [1999] propose un modèle de croissance semi endogène où la croissance exogène de la population a un impact positif sur la croissance du revenu par tête. Ce résultat est dû aux rendements croissants dans le secteur de l'innovation.

Dans le même temps, une vaste littérature affirme qu'une étude globale des comportements de fécondité et de leurs effets sur la croissance économique est impossible car ils ne sont constants ni dans le temps ni dans l'espace. Cette littérature propose une étude purement empirique plutôt que théorique de ces phénomènes[5]. Elle ne parviendra finalement pas à mesurer proprement l'impact de la croissance de la population sur l'épargne, les taux d'éducation, les dépenses de santé et les inégalités de revenus. En refusant toute modélisation des comportements de fécondité, ces études ne peuvent se prémunir contre les biais d'endogénéité et contre la critique de

[4]Voire également, par exemple, Segerstrom [1998] et Young [1998].

[5]Birdsall [1988] propose une élégante revue de cette littérature "purement empirique".

Lucas [1976].

L'économie démographique est entrée dans son ère moderne grâce aux contributions de Becker et d'Easterlin qui ont utilisé les outils de la Révolution Marginaliste pour analyser les comportements de fécondité. Malgré leur profonde opposition sur l'endogénéité des goûts, ces deux approches peuvent être réunies sous l'appellation Marginaliste. Elles sont également, toutes deux, des héritières des théories Malthusiennes et Ricardiennes car elles supposent que les comportements de fécondité au sein de la famille sont déterminés par l'environnement économique qui est, en retour, influencé par les comportements de fécondité. La Révolution Marginaliste leur permet d'analyser ce phénomène avec plus de rigueur. L'opposition entre ces deux modèles a été cruciale pour le développement de l'économie démographique.

Le modèle Beckerien est issu des contributions de Becker [1960], Becker & Tomes [1973] et Becker & Lewis [1976]. Dans leur cadre d'analyse, la fécondité, au niveau familial, est le résultat d'un processus de choix rationnel. Les parents sont altruistes dans le sens où ils incluent un indicateur du bien-être futur de leurs enfants dans leur propre fonction d'utilité. Dans la version la plus simple du cadre Beckerien, cet indicateur consiste en la qualité des enfants représentée par leur capital humain ou leur richesse. Dès lors, les parents valorisent à la fois la quantité de leurs enfants (le nombre d'enfants mis au monde) et leur qualité, en plus des commodités usuelles déjà présentes dans le modèle standard de choix du consommateur. Les parents doivent alors déterminer leur arbitrage optimal entre qualité et quantité.

Déterminer le choix optimal de quantité et de qualité ne relève pas d'un problème microéconomique standard car les parents font face à une contrainte de budget non linéaire. En effet, qualité et quantité entrent de manière multiplicative dans la contrainte de budget parentale. Dès lors, le coût relatif entre qualité et quantité

dépend des choix en terme de qualité et quantité: le coût marginal de la quantité est croissant avec la qualité. En d'autres termes, avoir un enfant de plus sera d'autant plus coûteux que l'investissement dans la qualité de chaque enfant est important. De même, fournir une unité de qualité en plus par enfant sera d'autant plus coûteux que les parents décident d'avoir un grand nombre d'enfants.

Comme le mentionnent Hotz *et al* [1993], un défi majeur pour le modèle Beckerien est d'expliquer pourquoi les familles à hauts revenus ont tendances à avoir moins d'enfants que les familles à faibles revenus et pourquoi, une hausse des revenus est associées à une baisse de la fécondité. Le modèle Beckerien affirme que la fécondité optimale diminue lorsque les revenus augmentent car les parents sont incités à substituer de la qualité à la quantité. Deux mécanismes peuvent être à l'œuvre pour expliquer cette substitution.

Le premier mécanisme est proposé par Becker & Lewis [1973] qui montrent que lorsque l'élasticité revenu de la demande de qualité est supérieure à l'élasticité revenu de la demande de quantité, les parents substituent de la qualité à la quantité lorsque leurs revenus s'accroissent. En effet, comme la qualité et la quantité sont supposées être des bien normaux, après une hausse du revenu parental, les demandes de quantité et de qualité augmentent a priori. La demande de qualité augmente plus si son élasticité revenu est supérieure à celle de la quantité. Cependant, la non linéarité de la contrainte budgétaire des parents implique un second effet de substitution: comme la hausse de la demande de qualité est plus forte que celle de la demande de quantité, le prix de la quantité augmente relativement au prix de la qualité. Les parents vont donc finalement substituer de la qualité à la quantité.

Le second mécanisme impliquant une substitution entre qualité et quantité suite à une hausse du revenu tient à la nature spécifique des coûts liés à la quantité. Mincer

[1963] affirme qu'élever des enfants est coûteux en terme de temps, particulièrement pour les femmes. Willis [1973] utilise cette hypothèse dans un modèle simple où les parents décident d'allouer leur temps entre élever leurs enfants et participer au marché du travail: élever des enfants implique un coût d'opportunité, celui du renoncement à participer au marché du travail. Cette hypothèse sera largement adoptée par la littérature (voire, par exemple, Galor [2005]). Comme élever des enfants est l'activité familiale la plus intense en terme de temps, un accroissement des revenus du travail accroît le coût relatif de la quantité par rapport à la qualité et à toutes les autres commodités. Les parents réduisent donc leur fécondité et investissent plus dans la qualité de chaque enfant.

La représentation Beckerienne des comportements de fécondité a été rapidement concurrencée par la théorie d'Easterlin. Le modèle de fécondité de la Synthèse provient des contributions d'Easterlin [1978] et Easterlin *et al* [1980]. Plutôt qu'opposé au modèle Beckerien, Easterlin tente d'étendre ce dernier. Il accepte la représentation d'une famille rationnelle maximisant son utilité sous contrainte de prix et de revenu. Il vise, cependant, à concilier ce cadre d'analyse avec le modèle d'offre d'enfants des démographes et avec la détermination endogène des préférences[6]

Incorporer le modèle d'offre d'enfants consiste essentiellement à inclure de nouvelles variables tel que la fréquence des grossesses, la mortalité infantile et la désutilité des contraintes liées à la contraception. Cette partie du projet de recherche d'Easterlin consiste en une amélioration naturelle du cadre Beckerien. Sans avoir recours au modèle de la Synthèse, les modèles de fécondité de cycle de vie permettent de représenter les décisions optimales en terme (i) de timing de la première naissance (voire, par exemple, Moffit [1984] et Happel [1984]), (ii) d'espacement des

[6] Birdsall [1988] propose une modélisation élégante de la contribution d'Easterlin.

naissances suivantes, (*iii*) de contraception[7]. Une vaste littérature modélise l'impact de la mortalité infantile sur les choix de fécondité sans avoir recours au modèle de la Synthèse[8].

L'endogénéité des goûts pour la fécondité et les commodités constitue le vrai point d'opposition entre Becker et Easterlin. Dans le modèle de la Synthèse, les normes sociales sont incluses comme un déterminant de la fonction d'utilité parentale. Les préférences déterminent les demandes individuelles de bien et d'enfants alors que les normes sociales déterminent les préférences. Pour une famille, à court terme, ces normes sont exogènes et constantes. A long terme, cependant, l'évolution des normes, et particulièrement des normes de fécondité, est déterminée par les mutations de l'environnement économique.

Easterlin et ses successeurs ne sont pas parvenus à endogénéiser l'évolution de long terme des normes sociales. Ceci a rendu le modèle de la Synthèse vulnérable à la critique de Becker & Stigler [1977]: expliquer l'évolution des comportements par des changement de goûts fournit une infinité de degrés de liberté. La littérature a donc adopté l'approche "purement économique" de Becker pour représenter les comportements de fécondité et expliquer leurs principales évolutions.

Après avoir discuté ses fondations, l'économie démographique s'est engagée dans l'analyse de problèmes que les modèles standards ne pouvaient investir de manière satisfaisante. Parmi ces problèmes, la transition démographique et les implications en terme de bien-être des comportements individuels de fécondité ont émergé

[7] Par exemple, Heckman & Willis [1975] et Wolpin [1984] montrent que les variations du profil du revenu parental de cycle de vie a un impact sur le timing de la première naissance et sur l'espacement des naissances suivantes.lorsque l'accès au marché du capital est restreint. Ils montrent qu'une croissance rapide du revenu familial incite les parents à repousser la première naissance et espacer les suivantes. En effet, l'importance du flux relatif de services provenant des enfants se réduit par rapport aux revenus du travail alors que les coûts d'élever les enfants restent inchangés.

[8] Voire Sah [1991], Kalemli-Ozcan [2003], Ehrlich & Lui [1991], Barro & Becker [1988], Cipriani & Blackburn [1998], etc.

comme deux enjeux majeurs. Les trois chapitres qui composent cette thèse tentent d'apporter une contribution à l'étude de ces questions.

Chapitre 1: Politiques Familiales: que nous enseigne le modèle Beckerien standard?

Analyser l'optimalité des comportements de fécondité nécessite de répondre à trois questions principales: "Comment définir l'optimalité lorsque la taille de la population est endogène?", "Quel est alors un bon objectif de bien-être social?" et "Pourquoi les choix individuels de fécondité peuvent s'éloigner de l'équilibre optimal?"

Les concepts d'optimalité et de bien-être social lorsque la fécondité est endogène

⊂ *Comment définir l'optimalité lorsque la fécondité est endogène?*

Appliquer le concept d'optimalité aux variables démographique n'est pas évident. La littérature a fortement évolué depuis l'approche préliminaire de Samuelson [1975]. Samuelson suppose une fécondité exogène et se concentre sur la question du taux de croissance optimal de la population dans un modèle à générations imbriquées. Un célèbre débat eu lieu entre Samuelson [1975] et Deardorff [1976] à propos de la réelle optimalité de la "Goldenest Golden Rule" ("la plus dorée des règles d'or"). La "Goldenest Golden Rule" représente le taux de croissance de la population qui maximise l'utilité sur le sentier de croissance stationnaire. Deardorff affirme que, pour toute spécification du modèle où l'utilité et la production respectent les propriétés de la Cobb-Douglas, la plus dorée des règle d'or de Samuelson consiste, en fait, en un minimum global et non un maximum. Puisque la fécondité n'est pas traitée comme un choix rationnel, cette littérature n'est pas capable d'expliquer

pourquoi la fécondité courante n'égalise pas la fécondité optimale. De plus, comme les déterminants de la fécondité ne sont pas expliqués, aucune recommandation de politique économique ne peut être faite.

Si le modèle Beckerien permet d'investir la question de l'optimalité des comportements de fécondité, il est d'abord nécessaire de raffiner le concept usuel d'optimalité. Deux contributions récentes de Golosov *et al* [2007] et Michel & Wigniolle [2007] redéfinissent la Pareto optimalité lorsque la fécondité est endogène. Ils affirment que le critère usuel doit être enrichi notamment parce que pour définir le meilleur des équilibres, il est nécessaire de comparer l'utilité qui est effectivement distribuée avec celle qui aurait pu être distribuée à un nombre d'agents différent. Par exemple, comme le soulignent Golosov *et al* [2007], la valorisation des agents qui auraient pu naitre mais qui ne sont pas nés doit être considérée pour déterminer la Pareto efficacité d'un équilibre: si certains agents peuvent naître sans diminuer l'utilité des agents déjà nés, l'allocation n'est pas optimale.

⊂ *Quel est alors un bon objectif de bien-être social?*

Lorsque le planificateur social peut choisir la taille de la population, répondre à cette question n'est pas neutre pour les résultats d'un modèle. Par exemple, maximiser l'utilité totale distribuée dans l'économie (utilité sociale de type Benthamienne) peut amener à un résultat très différent par rapport à maximiser l'utilité de la famille représentative (fonction d'utilité sociale de type Millienne). En effet, lorsque la fonction d'utilité Benthamienne est retenue, le planificateur social a une plus forte préférence pour la fécondité que lorsque la représentation Millienne prévaut. Nerlove *et al* [1986] étudient l'optimalité des comportements de fécondité dans un cadre où les parents valorisent à la fois le nombre de leurs enfants et la consommation qu'ils allouent à ces derniers. Ils montrent qu'à l'optimum de premier rang, la fécondité

est supérieure lorsque que le planificateur est Benthamien que lorsqu'il est Millien.

Blackorby *et al* [2006] soulignent les limites de l'approche Benthamienne et de l'approche Millienne. D'un côté, ils montrent que maximiser l'utilité totale peut mener à la "solution répugnante" dans laquelle la taille de la population est maximale et le bien-être moyen proche de zéro[9]. De l'autre côté, maximiser l'utilité moyenne implique que l'ajout, toute chose égale par ailleurs, d'un individu avec une très faible utilité sur l'ensemble de sa vie (même en deçà de la neutralité[10]) est désirable tant que la population existante bénéficie d'une utilité moyenne encore plus faible. Pour pallier ces faiblesses, Blackorby *et al* [2005] explorent le concept du niveau d'utilité critique qui, s'il peut être attribué à un nouvel individu sans réduire l'utilité de la population existante, mène à une alternative qui est aussi bonne que si ce nouvel individu n'était pas ajouté à la population.

De même, sachant que la fécondité est plus forte dans les familles les plus pauvres, si le planificateur social est Rawlsien (critère Maximin), le taux de fécondité optimal est plus fort que si le planificateur est Millien. Par exemple, Spiegel [1993] étend le cadre de Nerlove *et al* [1986] à un planificateur Rawlsien. Il montre que, malgré l'objectif Maximin, la fécondité à l'équilibre de laissez-faire peut être supérieure à la fécondité optimale.

Après avoir précisé les concepts d'optimalité et de bien-être social, la littérature à exploré les raisons pour lesquelles les comportements individuels de fécondité ne mènent pas à l'optimum social.

[9] Ils posent qu'un principe de population implique la solution répugnante si toute alternative dans laquelle tous les agents bénéficient d'un niveau d'utilité supérieur à la neutralité est classé comme aussi mauvais qu'une alternative dans laquelle chaque membre d'une plus grande population a un niveau d'utilité supérieur à la neutralité mais qui peut être arbitrairement proche de cette dernière.

[10] Blackorby *et al* [2006] précisent qu'une utilité sur l'ensemble de la période de vie égale à zéro représente la neutralité. Au delà de la neutralité, une vie vaut la peine d'être vécue, en dessous elle ne mérite pas d'être vécue. Du point de vue d'un individu, une vie neutre est une vie qui mérite autant d'être vécue que de ne pas l'être.

Les Raisons de l'Inoptimalité

Un comportement économique s'avère inoptimal soit parce qu'il existe une imperfection sur le marché où le bien est échangé, soit parce que ce bien est une source d'externalités. De par sa nature, la quantité d'enfants ne peut être échangée sur un marché[11]. On peut, dès lors, raisonnablement supposer que l'inoptimalité des comportements de fécondité ne provient que d'externalités. De telles externalités sont nombreuses. La fécondité peut être, d'une part, source d'externalités négatives car elle: (*i*) desserre la contrainte de budget des systèmes de retraite par répartition. Groezen *et al* [2003] et Loupias & Wigniolle [2004] montrent que la production marginale des enfants financera le système (*ii*) accroît le pouvoir géopolitique et militaire du groupe (une nation ou un groupe au sein d'une population). Dans leur article consacré à la catastrophe de l'Ile de Pâques, De la Croix & Dottori [2008] supposent que, dans la quête du pouvoir de négociation le plus élevé, le plus gros groupe a la plus grande probabilité de gagner la guerre, (*iii*) rend plus probable l'émergence d'innovations (voire, par exemple, Jones [1999]).

La fécondité peut être, d'autre part, une source d'externalités négatives car, par exemple: (*i*) elle intensifie l'exploitation des ressources non renouvelables, ce qui pose la question du développement soutenable (voire D'Alessandro [2007], d'Albis & Ambec [2008]). De la Croix & Dottori [2008] affirment que, si une plus forte fécondité augmente le pouvoir du groupe dans l'optique d'une guerre, ce phénomène peut mener à une course au peuplement incitant les groupes à continuellement accroître leur taille. Dès lors, une surpopulation et une surexploitation des ressources peuvent apparaitre et mener à l'effondrement du système, (*ii*) elle accroît la probabilité de

[11] De la Croix & Gosseries [2008] proposent un modèle où, pour atteindre le taux de fécondité national optimal, un marché de droits à procréer (ou de dispenses de procréation) est implementé. Dans ce cas, la quantité d'enfants devient un bien échangeable. Cependant, l'inoptimalité des comportements de fécondité ne peut pas venir d'imperfections sur ce marché qui assurent la décentralisation du taux de fécondité national optimal.

d'épidémie (voire par exemple Dasgupta [1993]) (*iii*) elle crée des problèmes de passager clandestin dans les communauté où élever un enfant est bon marché (par exemple en présence de travail des enfants) et où les ressources locales sont détenues par la communauté (faible définition des droits de propriétés). Dasgupta [2000] fournit de nombreuses illustrations de cette externalité dans les pays pauvres.

Contribution du Chapitre

S'il existe une large littérature explorant les externalités provenant des comportements de fécondité, il est surprenant de constater qu'il n'existe aucune étude explorant les propriétés d'optimalité de l'arbitrage entre qualité et quantité dans le modèle Beckerien de base. On pourrait arguer que déterminer les recommandations de politique économique de ce cadre basique est inutile car le manque de réalisme de ce dernier empêche de formuler des recommandations crédibles. Il est vrai que les nombreux raffinements du cadre Beckerien permettent d'analyser des problèmes qui s'avèrent bien en dehors du cadre du modèle Beckerien standard. Cependant, la littérature traitant de ces raffinements ne s'avère pas pleinement satisfaisante. Elle peut être divisée en deux groupes: les modèles incluant la fécondité sans prendre en compte la qualité[12] et les modèles qui endogénéisent l'arbitrage qualité-quantité.

Les modèles n'incluant que l'aspect quantité s'avèrent relativement incomplets. En effet, à cause de la non linéarité de la contrainte de budget parentale, rien n'assure qu'une "politique optimale" taxant ou subventionnant le revenu parental ou les naissances, dans les modèles sans qualité, ne distordent pas de manière inoptimal les investissements parentaux dans l'éducation et la santé des enfants. Les résultats de ces modèles sont affaiblis.

Balestrino *et al* [2000], Cigno & Pettini [2002], Nerlove *et al* [1986] et Spiegel

[12] Voire, par exemple, Fraser [2001] and Ab *et al* [2004].

[1993] explorent les politiques familiales optimales avec arbitrage qualité quantité endogène, leurs cadres ne s'avèrent toutefois pas suffisamment généraux. Balestrino *et al* [2000] and Cigno & Pettini [2002] s'intéressent à des problèmes spécifiques de taxation optimale du revenu en présence de problèmes de passager clandestin et d'hétérogénéité dans les capacités des parents à élever leurs enfants. Nerlove *et al* [1986] and Spiegel [1993] se placent dans un cadre finalement statique où les parents ne vivent que deux périodes et les enfants une seule.

Etudier les implications du modèle Beckerien de base pourrait permettre de clarifier les conclusions de la littérature économique explorant l'optimalité des comportements de fécondité. Le premier chapitre de cette thèse fournit cette étude et montre à la fois que les résultats des modèles sans qualité peuvent être contrariés et que la non linéarité fondamentale de ce modèle aboutit à des recommandations de politique économique non intuitives.

Il existe un consensus dans la littérature économique et au sein des institutions internationales quant à la légitimité des politiques d'éducation. Cette légitimité tient au fait que l'éducation est une source d'externalités positives. Je démontre, dans le cadre Beckerien standard[13], que l'éducation doit effectivement être subventionnée car elle est source d'externalités positives mais que toute subvention de l'éducation nécessite d'implémenter une politique complémentaire de subvention ou de taxation des naissances même si ces dernières ne sont pas source d'externalités. Cette politique pourra consister en une taxation des naissances pour un grand nombre de fonctions de bien-être social tel que les fonctions Milliennes et Benthamiennes.

La nécessité de subventionner ou taxer les naissances en compléments des poli-

[13] Le cadre Beckerien standard est défini dans les sous-sections précédentes. Les parents valorisent leur consommation de commodités, le nombre de leurs enfants et le capital humain qu'ils fournissent à ces derniers. Leur contrainte de budget n'est pas linéaire: les coûts de la qualité et de la quantité dépendent des choix de qualité et de quantité.

tiques d'éducation provient de la non linéarité de la contrainte de budget familiale. En effet, pour toute fonction de bien-être sociale, les parents n'investissent pas assez dans l'éducation de leurs enfants à l'équilibre de laissez-faire. Il s'ensuit que les dépenses d'éducation doivent être subventionnées. Supposons qu'il n'existe aucune externalité de fécondité, que tous les comportements soient observables et que le planificateur social cherche à maximiser l'utilité de la famille représentative[14]. La seule imperfection éloignant l'équilibre de laissez-faire de l'optimum social réside dans l'externalité d'éducation. Il semble alors intuitif que la subvention des dépenses d'éducation financée par un transfert forfaitaire devrait suffire à décentraliser l'optimum de premier rang. Je démontre que cette intuition n'est pas bonne car la non linéarité de la contrainte budgétaire familiale implique que la subvention des dépenses d'éducation réduit le coût total de la quantité d'enfants. Dès lors, lorsque la subvention à l'éducation est implémentée, les parents choisissent taux de fécondité trop élevé. Il devient donc nécessaire de taxer les naissances pour décentraliser l'optimum social. Lorsque l'hypothèse de planificateur Millien est relâchée, il est possible que le planificateur social ait une plus forte préférence pour la quantité d'enfants que les familles[15], ceci est vérifié dans le cadre d'un planificateur Benthamien. Je démontre alors, que subventionner les naissances en complément de subventions à l'éducation sera une politique optimale lorsque la distance entre préférences sociales et préférences individuelles dépasse un certain seuil.

Dans une extension de ce modèle, la mortalité infantile[16] est endogénéisée: les

[14]Ceci assure que le planificateur ne valorise pas plus la fécondité que les familles. Si l'on avait choisit un planificateur Benthamien, ce dernier aurait eu un gout pour la fécondité plus prononcé que celui des familles.

[15]Les raisons de l'écart entre préférences sociales et préférences individuelles pour la quantité d'enfant peuvent être nombreuses et provenir soit de la fonction de bien-être social même soit d'externalités. Les exemples d'externalités précédemment cités peuvent en partie s'appliquer ici.

[16]La mortalité infantile est ici entendue comme le risque de décès d'un enfant avant l'âge de cinq ans.

parents peuvent investir dans la santé de leurs enfants. Pour déterminer leur arbitrage optimal entre qualité et quantité, ils doivent maintenant déterminer le nombre de leurs enfants, l'investissement qu'ils consentent pour réduire la fraction d'enfants qui ne survivront pas à l'âge de cinq ans et l'éducation des enfants survivants. Dans ce cadre, les dépenses parentales de santé constituent une autre source d'externalités: le niveau de santé moyen détermine la probabilité d'épidémie dans la population (voire, par exemple, Dasgupta [1993]). Je montre alors que, malgré le fait que les parents n'investissent jamais assez dans la santé de leurs enfants à l'équilibre de laissez-faire, les dépenses individuelles de santé doivent être parfois taxées. En effet, comme dans le cas précédent, les dépenses d'éducation doivent être subventionnées et les naissances taxées[17]. La taxation des naissances joue alors le rôle d'une subvention indirecte aux dépenses de santé: pour atteindre le même nombre d'enfants survivants, il devient avantageux d'accroître ses dépenses de santé et de réduire le nombre d'enfants mis au monde. Dès lors, si la taxation des naissances est très forte, les dépenses de santé peuvent devenir trop importantes et doivent être taxées. Je montre particulièrement que la subvention des dépenses de santé aura d'autant plus de chance d'être positive que les externalités d'éducation sont faibles relativement aux externalités de santé.

Ce premier chapitre montre finalement que le cadre Beckerien standard fournit des recommandations de politique économiques qui ne s'avèrent pas intuitives. Il est alors clair que les conclusions des modèles de fécondité n'incluant pas la qualité, au moins dans sa dimension la plus simple de capital humain, sont affaiblies par ce résultat.

Représenter la qualité des enfants par leur futur capital humain a également été privilégié par la littérature analysant la transition démographique. Il apparait dans

[17] Cette extension ne se limite qu'au cas Millien où les naissances doivent être taxées.

cette dernière que le modèle Beckerien est un outil très performant pour expliquer les grands faits stylisés de cette transition mais qu'il s'avère limité pour intégrer la dimension culturelle du phénomène.

Chapitre 2: La Transmission Culturelle comme Facteur de la Transition Démographique

Une large majorité de pays a déjà connu la transition démographique. De plus, les démographes anticipent que l'Humanité toute entière aura achevé ce processus d'ici la fin du siècle. La transition démographique peut être simplement définie par la transition d'un régime de haute mortalité et haute fécondité à un régime de basse mortalité et de basse fécondité. Le décalage temporel souvent constaté entre la baisse de la mortalité et celle de la fécondité donne lieu à une accélération temporaire de la croissance démographique. En Europe Occidentale comme dans le reste du monde, le taux de croissance annuel moyen de la population mondiale était proche de 0,1% entre l'an zéro et 1820 (Maddison [2003]). Lorsque l'Europe de l'Ouest et les Etats-Unis sont entrés dans leur transition, ce taux de croissance annuel moyen a augmenté jusque 0,8% entre 1870 et 1913. L'entrée tardive, dans le processus, des pays moins développés a accru ce taux jusque 1,92% entre 1950 et 1973. L'Europe de l'Ouest a entamé sa transition démographique au début du $19^{ème}$ siècle. L'Angleterre et la France ont été les premiers pays à réduire leur taux de fécondité à long terme.

Les économistes proposent des modèles de croissance qui permettent à la fois de reproduire les faits stylisés de la transition démographique et de la Révolution Industrielle.

Les Analyses Traditionnelles de la Transition Démographique

Les démographes ont longtemps avancé que la chute de la mortalité et surtout de la mortalité infantile a été le principal facteur de la baisse de la fécondité à long terme[18]. Les progrès majeurs dans le domaine de l'hygiène et de la stérilisation ont permis une réduction de la mortalité infantile. Dès lors, les parents ont eu besoin de mettre moins d'enfants au monde pour avoir le même nombre d'enfant survivants qu'auparavant. Le décalage temporel entre baisse de la mortalité et baisse de la fécondité[19] est alors présenté comme une adaptation progressive des comportements de reproductions à la chute de la mortalité (voire, par exemple, Henry [1976]).

Cette explication s'avère cependant en partie contrefactuelle. Par exemple, Fernandez-Vilaverde [2004] montre, au cours d'une analyse quantitative, que le recul de la mortalité n'est pas significatif pour expliquer la chute de la fécondité pendant la transition démographique. Doepke [2005] montre également que la baisse de la mortalité infantile n'est pas responsable de la baisse de la fécondité nette pendant la transition démographique anglaise entre 1861 et 1951. De plus, les transitions démographiques française et américaine font office de contre-exemple; dans ces deux pays, la fécondité a commencé à décroître avant la mortalité.

Becker [1981] affirme que la baisse des taux de fécondité a été provoquée par l'accroissement des revenus lors de la Révolution Industrielle. Galor & Weil [1996] proposent un modèle où le progrès technique qui caractérise la Révolution Industrielle fait baisser l'écart de salaires entre hommes et femmes.car il réduit la complémentarité entre capital et force physique. Il accroît donc le coût de la quantité (prin-

[18] Des économistes ont également exploré ce mécanisme. Voire, par exemple, Kalemli-Ozcan [2003] and Eckstein *et al* [1999].

[19] Une fois que la fécondité a convergé vers sa faible valeur de long terme, la croissance de la population restera élevée durant plusieures périodes. Ce phénomène est nommé le momentum de la population. Il se définit comme la tendance de la croissance de la population à rester élevée au delà du moment où la fécondité a atteint son niveau de remplacement à cause de la forte concentration d'agents en âge de procréer.

cipalement supporté par les femmes[20]) relativement à celui de la qualité. Les parents tendent donc à avoir moins d'enfants auxquels ils fournissent plus d'éducation.

Galor & Weil [1999] proposent un modèle qui donnera naissance à la théorie de la croissance unifiée[21]. Ils y expliquent l'émergence de la Révolution Industrielle et de la transition démographique par un accroissement du progrès technique. Cette accélération du progrès technique provient d'effets d'échelle: une croissance larvée de la population fait naître un progrès technique faible. Ce progrès technique accroît le revenu des parents et les rendements de l'investissement dans le capital humain des enfants. Initialement, les rendements de l'investissement en capital humain et les revenus parentaux ne sont pas suffisants pour inciter les parents à investir dans l'éducation de leurs enfants. Les parents accroissent donc leur fécondité à la suite de la hausse du revenu (effet de revenu positif). Cependant, lorsque le progrès technique a atteint un certain seuil, l'investissement éducatif devient profitable et les parents substituent de la qualité à la quantité lorsque le revenu augmente suite au progrès technique. Dès lors, le niveau de capital humain moyen s'élève, un progrès technique endogène voit le jour et pousse l'économie sur un sentier de croissance de long terme où la fécondité converge vers un taux de fécondité stationnaire bas.

Une vaste littérature a complété cette approche fondamentale de Galor & Weil [1999] en explorant des mécanismes qui renforçent leurs conclusions. Parmi ces mécanismes, on peut citer: (i) l'accroissement de l'écart de salaires entre enfants

[20] Galor & Weil utilisent un modèle unitaire, c'est à dire un modèle où le couple agît finalement comme un seul agent. La littérature traitant des modèles de décision familiale a proposé une alternative à cette représentation: le modèle collectif (voire Browning *et al* [2006] pour une revue de cette littérature). Dans ce cadre, le comportement du ménage résulte de la négociation entre ses membres. En d'autres termes, le ménage ne se comporte plus comme un planificateur bienveillant. Cette littérature a enrichi certains résultats fondamentaux du modèle Beckerien. Il montre notamment que le revenu de la femme influence négativement la fécondité du ménage alors que le salaire de l'homme a un impact positif (voire, par exemple, De la Croix & Vander Donckt [2008]).

[21] Galor [2005a] proposent une revue de cette littérature.

et adultes lié au progrès technique qui accroît les rendements de l'investissement éducatif (voire Hazan & Berdugo [2002]), (*ii*) la hausse de l'espérance de vie qui accroît également les rendements du capital humain[22], (*iii*) l'hypothèse d'assurance pour les vieux jours (voire Ehrlich & Lui [1991]) et (*iv*) la chance, le hasard (voire Becker *et al* [1990]).

De la Croix & Doepke [2003] proposent un modèle où le différentiel de fécondité entre riches et pauvres influence la relation entre inégalités et croissance. Ils montrent que de plus fortes inégalités entre riches et pauvres ralentissent la croissance et le développement car les agents pauvres ont une plus forte fécondité que les riches et investissent moins dans l'éducation de leurs enfants. Leur proportion dans la population s'accroît donc et le capital humain moyen se réduit. Finalement, de plus fortes inégalités retardent la transition démographique et ralentit la croissance.

Si toutes ces contributions fournissent des explications consistantes de la transition démographique, elles ne peuvent prendre en compte un déterminant majeur de la baisse de la fécondité à long terme: les interactions entre les déterminants économiques et culturels de la fécondité. Le rôle des facteurs culturels dans la transition démographique en Europe de l'ouest a été très largement documenté par les démographes, les sociologues et les anthropologues[23]. Par exemple, les démographes du Projet de Princeton (voire Coale & Watkins [1986]) montrent que la transition démographique en Europe de l'Ouest résulte de l'interaction entre une transition économique et une transition culturelle. Une telle transition culturelle a rendu le contrôle des naissances acceptable. Lesthaeghe [1986] fournit également des faits empiriques montrant que l'évolution du Catholicisme a été décisive dans la

[22] Voire, par exemple, Hazan & Zoabi [2005], Moav [2005].

[23] Les démographes anthropologues montrent que l'évolution de la distribution des traits génétiques ou culturels peut expliquer la transition démographique. Voire, par exemple, Bergstrom & Stark [1993] et Fricke [1997].

décroissance de long terme de la fécondité en Europe de l'Ouest.

En étudiant le cas de l'Afrique Sub-saharienne, Dasgupta [2000] affirme que la conformité envers les valeurs culturelles ancestrales explique en partie la persistance de forts taux de fécondité. Il précise notamment que la procréation n'est pas qu'un acte privé, c'est également un acte social influencé par l'expérience familiale et le milieu culturel.

A la suite de Knodel [1988], une vaste littérature propose des études restreintes au niveau d'un pays voire même de très petites zones géographiques[24] (régions ou villages) afin d'isoler les facteurs culturels (voire par exemple, Assve et Altankhuyag [2006] et Zachariah [2006]).

L'existence de toutes ces études constitue une incitation à proposer un modèle où l'interaction entre dynamiques culturelles et économiques explique la transition démographique. Modéliser cette interaction exige toutefois de renoncer à l'hypothèse de préférences stables et exogènes.

Contribution du Chapitre

Ce chapitre vise à proposer un modèle de fécondité où l'interaction entre déterminants économiques et culturels de la fécondité explique la transition démographique. Il est utile, pour ce faire, de rendre endogènes les préférences et leur transmission. Utiliser des préférences endogènes et non constantes n'est pas usuel pour les économistes; une littérature récente propose des cadres d'analyse y parvenant sans tomber sous la critique de Becker & Stigler [1977]. On peut citer, entre autres, l'endogénéisation des normes sociales[25], l'investissement parental dans la patience

[24] Hammel [1990] et Mason [1997] critiquent la localisation croissante des études de la transition démographique par les démographes. Ils affirment que la forte localisation de ces études empêchent la validation d'une théorie générale de la transition démographique.

[25] Voire, par exemple, Duesenberry [1949], Blomquist [1993], Lindbeck [1995], Lindbeck *et al* [1999] et Palivos [2001].

des enfants[26] et les approches évolutionnaires[27].

Galor & Moav [2002] fournissent une contribution majeure aux explications évolutionnaires de la baisse à long terme de la fécondité. Ils supposent l'existence de groupes "génétiquement" différents: un groupe d'agents orientés vers la qualité et un groupe d'agents orientés vers la quantité[28]. La transmission des préférences (type génétique) des parents vers les enfants est parfaite. A l'échelle de la population, le différentiel de fécondité entre les groupes régit l'évolution des préférences: le groupe avec la fécondité la plus élevée devient majoritaire et influence fortement les préférences moyennes.

Inclure des processus évolutionnaires permet de relâcher l'hypothèse de préférences stables et exogènes. En effet, l'interaction entre conditions économiques et évolutionnaires explique les changements à long terme du goût pour la quantité d'enfants. Une limite de cette explication évolutionnaire tient au fait que seule le différentiel de fécondité entre les groupes compte pour expliquer l'évolution de long terme des préférences. Ceci empêche de décrire le rôle de la culture, des normes sociales et des institutions dans la transition démographique.

Bisin & Verdier [2001] proposent un modèle endogénéisant la transmission culturelle et la dynamique des préférences. Dans ce cadre, la transmission des préférences des parents vers les enfants n'est pas parfaite car elle est culturelle plutôt que génétique. Les parents doivent fournir un effort pour transmettre leurs préférences à leurs enfants. S'ils échouent, leurs enfants seront directement socialisés par la société. L'évolution des préférences est alors endogène, elle résulte de l'interaction entre comportements économiques et culturels des agents et de la composition culturelle de la population.

[26] Voire Doepke & Zilibotti [2008].
[27] Bergstrom [1996] fournit une revue de cette littérature.
[28] Cette hypothèse est élégamment justifiée dans l'article de Galor & Moav.

Ce second chapitre utilise un cadre à la Bisin & Verdier pour élaborer un modèle de fécondité à générations imbriquées où les interactions entre facteurs culturels et économiques expliquent la baisse de la fécondité à long terme. Je suppose l'existence de deux cultures. la première culture est dite "Traditionnelle". Les Traditionnels suivent une norme de fécondité élevée et adoptent un mode de production rural agricole. La seconde culture est dite "Moderne", ses membres ne suivent aucune norme de fécondité[29] et adoptent un mode de production industriel. Chaque agent, arrivé à l'âge adulte, doit déterminer sa consommation de commodités, le nombre d'enfants qu'il met au monde et l'effort de socialisation qu'il fournira pour transmettre sa culture à ses enfants. Parce que les parents choisissent rationnellement leur effort de socialisation, la composition culturelle de la population dépend crucialement des conditions économiques en vigueur tel que le coût d'élever un enfant, le revenu parental et le différentiel de productivité entre les modes de production.

Dans ce cadre, un choc de productivité en faveur du mode de production industriel produit un "effet évolutionnaire" en faveur des Traditionnels" et un "effet culturel" en faveur des Modernes. En effet, un tel choc accroît l'écart de richesse entre Modernes et Traditionnels. La déviation culturelle[30] devient plus acceptable pour les Traditionnels car leurs enfants bénéficieront de revenus plus élevés s'ils adoptent la culture moderne. En conséquence, les Traditionnels réduisent leur effort de socialisation. Ils accroissent dans le même temps leur fécondité car l'utilité espérée par enfant augmente. L'inverse est vrai pour les Modernes: un accroissement de leur revenu relatif rend la déviation culturelle de leurs enfants plus coûteuse en terme d'utilité. Ils accroissent donc leur effort de socialisation et comme les enfants sont

[29] Cette hypothèse trouve des points communs avec celle de Galor & Moav [2002]. Je fournis cependant, dans ce chapitre, une justification culturelle plutôt que génétique. Je me concentre principalement sur la religion.

[30] Une déviation culturelle se produit lorsqu'un enfant adopte une culture différente de celle de son parent.

intensifs en temps, ils réduisent leur fécondité. Dès lors, comme les Traditionnels accroissent leur fécondité alors que les Modernes réduisent la leur, la proportion de Traditionnels dans la population tends à croitre: ceci est appelé l'effet évolutionnaire. Cependant, comme les Modernes accroissent leur effort de socialisation alors que les Traditionnels réduisent le leur, la proportion de modernes tend à augmenter dans la population: ceci est appelé effet culturel.

Les interactions entre effets culturels et évolutionnaires impliquent trois résultats essentiels. Premièrement un choc technologique asymétrique en faveur du secteur industriel provoquera une transition démographique uniquement s'il est accompagné par un transition culturelle donnant la majorité aux Modernes. En d'autres termes, le progrès technique asymétrique doit être suffisamment soutenu pour faire diminuer la fécondité des Modernes et provoquer une transition culturelle où les Traditionalistes dévient massivement vers la culture Moderne.

Deuxièmement, si les Traditionnels sont fortement attachés à la perpétuation de leur culture, ils maintiendront des efforts de socialisation élevés en dépit du progrès technologique asymétrique[31]: l'effet culturel est faible relativement à l'effet évolutionnaire. Dès lors, les transitions culturelle et démographique apparaîtront plus tard, pour un écart technologique plus important entre les secteurs de production. Une fois enclenchée, la transition démographique sera plus rapide car les Modernes deviendront majoritaires au moment où leurs taux de fécondité seront déjà très faibles. Il est important de noter que le progrès technique asymétrique peut provoquer une hausse initiale de la proportion de Tradionalistes dans la population et un accroissement temporaire du taux de fécondité moyen[32].

[31] Je suppose que, faisant face au progrès technique en faveur du mode de production industriel, les Traditionnels n'abandonnent pas leur mode de production dont l'efficacité relative décroît. La persistance culturelle de comportements économiques inefficaces est reportée et expliquée dans bon nombre d'études tel que Salamon [1992], Grusec & Kuckzynski [1997] et Guiso *et al* [2006].

[32] La hausse temporaire de la fécondité au début de la Révolution industrielle est un fait stylisé

Troisièmement, dans un environnement où le mode de production industriel est initialement peu productif et ne bénéficie pas d'un progrès technique suffisamment rapide, la culture Moderne peut disparaître à long terme. A l'inverse, si le progrès technique asymétrique en faveur de l'industrie est fort, la culture Traditionnelle peut disparaître à long terme. En effet, comme la transmission des préférences n'est pas parfaite car culturelle plutôt que génétique, la mobilité entre les groupes peut conduire à la disparition de l'un d'entre eux: lorsque les traits culturels d'un groupe sont trop fortement inefficaces sur le plan économique, ses membres finissent par ne plus essayer de transmettre leur culture à leurs enfants. Il est important de noter que le progrès technique asymétrique en faveur de l'industrie n'a pas besoin d'être permanent pout que la culture Traditionnelle disparaisse. Il a uniquement à maintenir un écart de revenus suffisant entre les deux modes de production pendant une période de temps limitée. En effet, la disparition d'une culture étant un phénomène irréversible, une fois que l'un des groupes a disparu, le caractère asymétrique du progrès technique asymétrique ne comptera plus.

Ce chapitre propose donc un modèle simple qui permet de reproduire un certain nombre de faits stylisés de la transition démographique en Europe de l'Ouest. En effet, l'étude de la transition démographique en Europe de l'Ouest par les démographes et les Historiens montrent que l'apparition de la transition démographique a été fortement liée à l'urbanisation, l'industrialisation *et* la sécularisation définie comme un processus retirant aux autorités religieuses certains aspects de la vie sociale et culturelle. Ces travaux montrent que la réduction à long terme de la fécondité est le fruit de la mutation de l'environnement économique et social et de la sécularisation. Cette dernière a été une condition nécessaire à la transition démographique

reporté, par exemple, par Galor [2005a & b].

Dans ce chapitre, les Traditionalistes peuvent être identifiés comme Catholiques et Calvinistes. En accord avec leur culture, ils essaient de respecter une norme de fécondité élevée et prennent part à un mode de production familial agricole. Les Modernes ne sont pas influencés par les institutions religieuses, leurs choix de fécondité ne sont pas déterminés par une norme explicite et ils prennent part au secteur industriel (ils sont sécularisés). Une partie du chapitre est dédiée à la discussion de ces hypothèses. De nombreuses illustrations empiriques sont apportées pour l'Europe de l'Ouest à la veille et pendant la Révolution Industrielle[33]. La sécularisation de la population est alors représentée par la baisse à long terme de la proportion de Traditionnels. En effet, cette baisse correspond à un recul de l'influence des normes religieuses à l'échelle de la société. Lorsque le progrès technique asymétrique est suffisamment fort[34], la population entame sa sécularisation et sa transition démographique. La survenance de ce processus est conditionnelle à l'intolérance des Traditionnels[35]. Si cette intolérance, résultant en partie de la doctrine de l'Eglise, est forte, la population entame plus tardivement sa sécularisation et sa transition démographique. La baisse de sa fécondité sera alors plus tardive mais plus rapide[36].

Au delà des travaux des démographes, des historiens et des sociologues, la prise en compte de variables culturelles dans l'explication de la dynamique des population trouve également ses fondements dans une littérature empirique récente. Les économistes bénéficient, depuis peu, de bases de données suffisamment riches pour étudier l'impact des variables culturelles et, spécialement religieuses, sur les com-

[33]Voire par exemple, Lesthaeghe & Wilson [1986], Lesthaeghe [1977], Van Poppel [1985], Van Bavel & Kok [2005], Neven & Oris [2003], etc.

[34]Le biais industriel du progrès technique durant la Révolution Industrielle est fortement documenté. Voire, par exemple, Bairoch [1997].

[35]L'intolérance se comprend ici comme l'attachement d'un agent, toute chose égale par ailleurs, à la perpétuation de sa culture dans sa propre dynastie. Dans ce chapitre, les Modernes font preuve d'intolérance au même titre que les Traditionnels.

[36]Ce fait est rapporté, par exemple, par Van Heek [1956] pour la Hollande et Lesthaeghe [1977] pour la Belgique.

portements de fécondité dans un cadre où les conclusions Beckerienne peuvent également être testées. Le troisième chapitre de cette thèse fournit une contribution à cette littérature en étudiant le cas de la France.

Chapitre 3: Religion et Fécondité, le Cas Français

Une très brève revue de la littérature

Les économistes ont récemment entamé une étude de l'impact de la culture et des normes sociales sur les comportements économiques. Grace au développement de bases de données incluant un grand nombre de proxies pour la culture, ils sont à même de discriminer entre variables culturelles et non culturelles ainsi que de tester la causalité entre culture et comportements économiques[37].

Fernandez & Fogli [2007] ont fourni une contribution majeure à l'étude du lien entre comportements de fécondité et variables culturelles. Ils parviennent à approximer la culture par des variables purement économiques. Ils montrent, pour les Etats-Unis aux $20^{ème}$ siècle, que la culture nationale des immigrantes a un impact significatif sur leur fécondité et leur participation au marché du travail. Ils approximent la norme culturelle des immigrants vis à vis de la fécondité et de la participation des femmes au marché du travail par le taux de fécondité moyen et la participation moyenne des femmes au marché du travail dans le pays d'origine (approche épidémiologique). Ils trouvent que, toute chose égale par ailleurs, le taux de fécondité moyen du pays d'origine a un impact positif et significatif sur la fécondité des immigrants.

La littérature a également privilégié une autre méthode pour mesurer l'impact de la culture sur les comportements de fécondité. Cette méthode approxime la cul-

[37] Guiso *et al* [2006] fournissent une revue de cette littérature.

ture par des variables religieuses. Cette méthode est depuis longtemps utilisée par les démographes et les sociologues. Les économistes n'y ont pas réellement eu recours parce que les bases de données disponibles ne contenaient pas suffisamment de variables économiques satisfaisantes. L'économétrie moderne indique clairement que mesurer l'impact de variables culturelles en omettant les variables économiques fondamentales conduirait à des résultats non valides. Cependant, les bases de données récentes incluent de manière satisfaisante des données religieuses et économiques. Par exemple, Adserá [2006] et Branas-Garza & Neuman [2006] montrent qu'après avoir contrôlé par les déterminants économiques usuels, l'intensité de la pratique religieuse a un impact positif et significatif sur la fécondité[38].

Contribution du Chapitre

Le troisième chapitre de ma thèse fournit une contribution à la littérature récente qui explore l'impact de la religion et de la transmission culturelle sur les comportements de fécondité dans un cadre où les effets Beckeriens standards peuvent être contrôlés. La base de données "Enquête Mode de Vie des Français" constitue la première occasion de mesurer l'impact de la religion et de la religiosité sur les comportements de fécondité en France. En effet, la loi française rend très difficile la collecte et l'exploitation de données religieuses.

La base "Enquête Mode de Vie des Français" fournit des variables religieuses précises tel que la religion d'origine, la croyance, la fréquence à laquelle les répondants assistent aux offices religieux et l'estimation par les agents de l'importance de la religion dans leur propre vie. La richesse de l'enquête ne se limite pas aux variables religieuses, sont également disponibles des informations sur la situation économique du répondant (revenus, épargne, richesse, parcours sur le marché du

[38] Une revue de cette littérature est fournie dans le chapitre.

travail...), son mode de vie (santé, addictions, habitudes de consommation...), son attitude face au risque et ses valeurs (religion, politique, attitude face aux étrangers, valeurs familiales...).

A l'aide de régressions de Poisson, je montre que les seules variables religieuses qui ont un impact sur la fécondité sont celles mesurant le degré de pratique; la religion d'origine et la croyance n'ont pas d'impact significatifs. Je propose deux mesures de la religiosité. La première est usuelle dans la littérature, elle correspond à la fréquence à laquelle le répondant assiste aux offices religieux. Il apparaît que la fécondité d'une femme assistant souvent aux offices religieux (1 fois par semaine) est 24% plus élevée que la fécondité d'une femme n'assistant jamais aux offices. La seconde mesure de la religiosité correspond à l'estimation par le répondant, sur une échelle allant de zéro à dix, de l'importance de la religion dans sa vie.

Dans cette étude, l'impact de la culture sur la fécondité ne se limite pas aux variables religieuses. En effet, j'explore deux aspects de la transmission culturelle au sein de la famille: l'influence de la fécondité des parents du répondant et l'impact de la transmission du Sens de la Famille[39] entre générations. Je montre que ces deux canaux de transmission sont aussi importants que la religion pour expliquer la fécondité des agents. Avoir grandi dans une famille nombreuse dans laquelle les valeurs familiales sont très importantes accroît significativement la fécondité des agents toute chose égale par ailleurs.

Ces résultats sont contrôlés pour les variables usuelles tel que le statut des agents sur le marché du mariage. Je montre également que les conclusions des modèles

[39]La transmission du Sens de la Famille est mesurée par la réponse aux deux questions suivantes: "Parmi les valeurs suivantes, quelles sont les trois premières que vous cherchez ou chercheriez à transmettre à vos enfants?" et "Et quelles sont les trois principales que vos parents ont cherché à vous transmettre?" Parmis les réponses possibles, se trouvaient "La générosité", "La joie de vivre", 'L'honnêteté", "Le sens de la Famille"... Un score allant de zéro à deux est construit, il est croissant avec le nombre de fois où le répondant a choisi "Le Sens de la Famille".

Beckeriens sont validées: le revenu de l'homme a un impact positif sur la fécondité de la femme alors que le propre revenu de la femme a un impact négatif. L'éducation de la femme a un impact négatif dans le sens où les femmes les moins éduquées ont moins d'enfants que les autres. L'âge de l'agent est la variable la plus importante pour expliquer la haute fréquence d'observations où le nombre d'enfants est égal à zéro. Ceci traduit le fort ajournement de la première naissance qui est une caractéristique commune à tous les pays développés. Il apparaît également que les femmes les plus éduquées et habitant en zone urbaine sont les plus susceptibles de choisir de ne pas avoir d'enfants.

Un certain nombre de tests montrent que ces résultats sont robustes au changement d'hypothèse sur la distribution[40], à la sélection de l'échantillon[41] et à la stratégie retenue pour mesurer l'effet de l'âge. La correction du biais d'endogénéité pour le revenu de la femme montre à la fois que les effets de revenus restent présents et que les effets culturels en sont indépendants.

Conclusion Générale

En analysant la problématique des populations, les économistes tentent de répondre à des questions fondamentales. Existe-t-il une taille optimale pour l'Humanité? Une petite population jouissant d'un haut niveau de vie est-elle préférable à une plus grande population bénéficiant d'un plus faible niveau de vie? La croissance exponentielle de la population mondiale est-elle une chance ou une menace pour notre bien-être et notre survie à long terme? Comment peut-on expliquer la baisse

[40] Les résultats sont valides en menant des régressions de type Moindres Carrés Ordinaires et Probit Ordonné.

[41] Les effets culturels et religieux sont toujours vérifiés lorsque l'échantillon retenu correspond aux femmes de plus de 45 ans ainsi qu'à l'ensemble de la population, c'est à dire hommes et femmes sans aucune limite d'âge.

historique de la fécondité qui caractérise la transition démographique à laquelle le monde dans son ensemble paraît voué?

Je fournis, dans cette thèse, une contribution aux réponses des économistes à ces questions. Je montre particulièrement deux résultats. Premièrement, lorsque l'on veut traiter de la problématique de la taille optimale des populations à l'aide du cadre Beckérien où la taille des familles est un choix rationel, il est impératif de prendre en compte la "qualité". En effet, dans ce cas, la non linéarité de la contrainte de budget parentale implique que même si la quantité n'est soumise à aucune externalité, la correction des externalités pesant sur les choix d'éducation et de santé ne suffira pas à atteindre la taille optimale de la population. Deuxièmement, je montre que les modèles de fécondité usuels proposés par les économistes ne permettent pas de prendre en compte la dimension culturelle de la transition démographique. Le fait que la transition démographique est le fruit de l'intéraction entre une transition économique et culturelle a été largement mis en évidence par les démographes, les historiens et les sociologues. Je propose donc un modèle de fécondité et de transmission culturelle qui permet de modéliser en partie ce phénomène. Les résultats empiriques que je met en évidence sur données françaises montrent que l'intégration de mécanismes culturels en plus des mécanismes économiques usuels constitue une piste de recherche riche et complexe.

General Introduction

"No goal is more crucial to healing the global environment than stabilizing human population. The rapid explosion in the number of people since the beginning of the scientific revolution and especially during the latter half of this century is the clearest single example of the dramatic change in the overall relationship between the human species and the earth's ecological system. (...) It is also crucial to remember that the difference between ultimately stabilizing the population at 10 or 11 billion rather than 14 or 15 billion is profound in terms of our human impact on the environment as well as the people of the earth."

Al Gore (1992), Vice President of the United States from 1993 to 2001

Nobel Peace Price 2007

"La plupart des états d'Europe Occidentale sont en train de se suicider, de se suicider par la démographie, sans même en avoir conscience"

Michel Rocard (1989) on the low fertility in Europe[42]

French Prime Minister from 1988 to 1991

Because of its evident human dimension, the understanding of reproduction behaviors largely falls under the scope of interest of human scientists like demographers,

[42]Translation from French: "Most Western European countries are committing suicide, they commit demographic suicide even not being conscious of it".

sociologists, anthropologists and... economists. From 1 AC to 2008, humanity rose from 170 million people[43] to 6,705 billions[44]. This dramatic change has been a source of fears and debate on "too high" population growth rates in developing economies. Likewise, "too low" population growth rates in developed economies have also given birth to strong concerns. The above citations from Al Gore and Michel Rocard sound like a version of these concerns at the political level. They both assume that there exist an optimal population growth rate and an optimal population size.

Economists show that asserting the existence of an optimal size for population raises complex questions like wether a small population enjoying high standard of living is more desirable than a larger population with smaller standard of livings. Such a question is closely related to the valuation of the lives of agents who could have been born but were not. Furthermore, if an optimal population size can be defined, one has to find out why individual choices depart from this most desirable situation.

The link between population growth and development must also be investigated. If there is little doubt, as mentioned by Al Gore, that larger populations intensify the use of non renewable resources, there is also much evidence that the increase in the size of populations has been responsible for a large set of advances in the World. Indeed, the pressure of populations on resources is a driven force for innovation which could, in turn, increase the quantity of available resources.

Empirical evidence show that the process of development is not neutral for population growth rate. A large part of humanity has engaged in a process of demographic transition leading to a reduction of both mortality and fertility and a temporary increase in its growth rate. Understanding the determinants of this major evolution

[43]Estimation from the US Census Bureau.
[44]Estimation from World Population Datasheet 2008.

could determine the conditions under which developing countries will finally achieve the stabilization of the human population size.

My thesis provides a contribution to economists' continuous attempts at understanding the determinants of population growth and its implications for human well-being. It particularly focuses on fertility behaviors which are the main determinant of population growth.

The present introduction consists of three parts. In the first one, I propose a brief historical overview of the economic analysis of fertility and population growth. I especially show that, after the failure of classical economists at proposing a consistent theory of population growth, economics has long been disinterested in explaining population phenomena. The renewal of the economic analysis of population issues has come from the contributions of Becker [1960] and Becker *et al* [1973, 1976].

The Beckerian representation of fertility behaviors is presented in part 2. Becker's main innovation consists in applying the marginalist theory to fertility behaviors. In this section, I also highlight how this marginalist theory has been challenged by Easterlin's theory. Easterlin essentially tries to incorporate more features of demographics and sociology into the marginalist framework but fails at making them endogenous. Finally the Beckerian analysis has been favored by the literature to investigate population problems.

Part 3 presents two population issues among the most crucial ones: the optimality of fertility behaviors and the long run dynamics of population growth. I also present, in this part, the description of the three chapters which compose my thesis and which provide contributions to the understanding of these two population problems.

1 The Birth of the Economic Analysis of Fertility

The relationship between economics and demographic phenomenons takes its root in classical economics. Classical economists made demographic variables endogenous in their global representation of economies. Birdsall [1988] divides classical economists between "pessimists" and "optimists". The most famous pessimistic theory lies in the Malthus' Essay on Population [1798], besides, pessimism toward population growth is often summarized as Malthusianism. In his analysis, both economic and demographic fluctuations are driven by reproduction behaviors at the scale of the family which maintain the economy in a perpetual stagnation in poverty. Indeed, Malthus argues that, when income increases above its subsistence level agents marry earlier on average and have more children who experience lower mortality rates due to better nutrition and health. The rise in the population size induces stronger labor supply and demand for food in the next period. Because of decreasing returns, wages decrease while food prices increase due to the fixity of land. Then, income falls below its subsistence level, marriages and fertility both decrease while mortality increases. The economy finally goes back to its long run situation where population and standard of livings are stable.

In his Principle of Political Economy and Taxation [1817], Ricardo delivers another pessimistic vision of the interplay between economic and demographic dynamics. His theory on population is very close to Malthus'. He argues that, in the long run, wages cannot be different from their natural price

> "*which is determined by the quantity of food, necessaries, and conveniences required by laborers to perpetuate their race, without either increase or diminution that is, at a level corresponding to zero population growth. Wages higher than the subsistence level cause the condition of laborers to*

> *be "flourishing and happy" and lead to the growth of the laboring population, eventually driving wages back to their natural price. Conversely, privations resulting from the market price of labor falling below the price corresponding to the subsistence level lead to population decline, thus setting into motion market forces that make the wage rate climb back to subsistence level*"[45].

For Ricardo, decreasing returns in the production of corn and in labor force make inevitable the convergence of wages to their natural price[46].

All classic economists did not however develop pessimistic thesis. In *the Wealth of Nations* [1776], Adam Smith argues that demographic growth fastens economic growth: a larger population increases the market's size which, in turn, incites to innovation, deepens the division of labor and finally increases productivity. Marshall states that "*increase in population and/or its concentration is a source of increasing return, at least in the absence of emerging limitations*"[47].

Marshall [1920], one of the fathers of neoclassical economics, also argues that larger populations allow the economy to escape from decreasing returns (see Birdsall [1988]). He focuses on the relation between health and strength (both physical and mental), and the relation between health, moral and material wealth. He underlines the importance of the increase of knowledge, especially of medical science which

[45] From Population Council study "Ricardo on Population" [1988].

[46] Nevertheless, the Ricardo's pessimism has to be put into perspective. He, indeed, explores three possibilities making the escape from the low development trap possible (see "Ricardo on Population" by the Population Council [1988]). First, improvements in agriculture, greater accumulation of capital, stronger division of labor and the opening of new markets are temporary instruments to make current wage stronger than natural wages. Second, increases in the subsistence wage rate could lead to dissociate subsistence wages to high fertility (he argues that the definition of subsistence wages is social rather than biological). Third, the apparition of births control would be the final mean to make the "superabundant population" disappear. Even if Ricardo did not believe in their feasability, he makes them conceivable.

[47] From Spengler [1970].

will improve health, diminish mortality, enhance efficiency and, in the end, increase production.

Notice that, contrary to Malthus and Ricardo, Smith and Marshall did not give a central role to the interaction between economic and demographic behaviors. Therefore, they did not provide a unified optimist theory of the link between population and economic growth[48].

The great take-off of European economies during the Industrial Revolution rapidly invalidated the malthusian and ricardian conclusions. Indeed, after the beginning of the Industrial Revolution in Europe (around 1820), population growth turned out to be positively linked with output growth[49]. This can be considered as a reason why the marginalist revolution first neglected the analysis of reproduction behaviors. Another reason could lie in the reluctancy of marginalist economists to apply their theory to reproduction behaviors. Whatever the reasons, modern economics began its history without applying the concept of rationality to the analysis of fertility. Henceforth, the opposition between pessimists and optimists became less visible. Since the failure of classical analysis, economics left the analysis of population problems neglected. At best, fertility has been treated as exogenous and as an instrument of economic policy.

Even in their long run growth models, Solow [1956] and Ramsey [1928] assume population growth to be exogenous. They modelize it as a restraint for consumption growth and for long run consumption. All extensions of these frameworks (for instance, see Lewis [1954], Mankiw *et al* [1992], Lucas [1988], etc.) argue that, all other things being equal, a higher population growth implies a smaller labor productivity. So it requires higher savings to reach the same capital per capita and

[48] In a sense, by proposing such a unified theory, Malthus and Ricardo paved the way of modern unified growth theories which will be presented thereafter.

[49] See, for instance, Galor [2005a, 2005b].

it reduces consumption.

Once again, optimistic approaches focus on scale effects. For instance, Boserup [1965] and Simon [1981] find that larger populations exert a pressure for innovation and allows for scale economies. Jones [1997] proposes a simplified framework to study the impact of the scale of populations on innovation possibilities. He shows that this optimistic vision can be counterbalanced by less intuitive effects like fishing out. Contrary to exogenous growth models, endogenous growth models find that the size of populations has a positive impact on the growth of income per capita (see, for instance, Aghion & Howitt [1998]). This scale effect has been criticized (see Amable [2000]) because it is counterfactual. Papers from Eicher & Turnovski [1999] and Jones [1999][50] suppress scale effects. Jones [1999] proposes a model of semi endogenous growth where the exogenous growth rate of population positively influence the growth of income per capita. This result comes from increasing returns in the sector of innovation.

In the same time, an extensive literature argues that a global study of reproduction behaviors and of the effects of population growth is not possible because they are not constant in time and space. This literature proposes an empirical investigation of the effect of population growth on economic variables rather than a theoretical approach. It cannot be classified between optimists and pessimists[51]. It finally failed in properly measuring the impact of population growth on saving rates, school enrollment ratios, health expenditures and on income inequalities. Indeed, one can reasonably suspect that decisions on fertility, children's education, health and on workforce participation are simultaneous. It results that their relationship with fertility is at best correlative but not causal. By refusing the modelization of fertil-

[50] See also, for instance, Segerstrom [1998] and Young [1998].

[51] Birdsall [1988] proposes an enlightening review of this "purely empirical" literature.

ity behaviors, these studies cannot avoid strong endogeneity biases. Furthermore, the lack of structural models supporting these studies makes them falling under the scope of Lucas' critic [1976].

The economic analysis of fertility entered in its modern era with the contribution of Becker [1960]. This contribution paved the way for analyzing fertility behaviors with the tools of the Marginalist Revolution.

2 Modern Foundations: Becker vs Easterlin

The need of microeconomic foundations for the analysis of fertility has been fulfilled by two major contributions: the Beckerian model of fertility and the Synthesis model of fertility. Despite their profound opposition on the endogeneity of tastes, these two approaches can both be considered as "Marginalists". Furthermore, they can be introduced as heirs of the Ricardian and Malthusian frameworks. Indeed, they assume fertility behaviors of families to be determined by economic variables which are, in turn, influenced by fertility behaviors. However, the Marginalist Revolution has allowed them to investigate this phenomenon with more rigor. The opposition between these two models has been crucial to the development of the modern economic literature on demographic economics.

The Beckerian model of fertility comes from Becker [1960], Becker & Tomes [1973] and Becker & Lewis [1976]. In this framework, fertility, at the family level, results from a rational decision process. Parents are altruistic in the sense that they include their children future well-being in their own utility function. In the simplest version of the Beckerian approach, this well-being corresponds to the children's quality represented by their human capital or wealth. So parents value both the quantity of children (the number of children they give birth to) and their quality in

addition to usual commodities already present in the usual microeconomic theory. Thus, they have to determine their optimal trade-off between quality and quantity.

The determination of optimal choices on quantity and quality does not consist in a standard microeconomic problem because parents face a non linear budget constraint. Indeed, quality and quantity enter multiplicatively in the parental budget constraint. Then, the cost of quality relative to quantity is not independent of parental choices on quality and quantity. More precisely, the marginal cost of quantity is increasing in quality. That is to say, having one more child will be all the more costly that parental investment in each child's quality is strong. Conversely, providing one more unit of quality per child will be more costly when parents decide to have a lot of children.

As mentioned by Hotz *et al* [1993], one major challenge for the Beckerian model of fertility consists in explaining why families with high incomes tend to have less children than families with low incomes and why increasing incomes are associated with decreasing fertility. The Beckerian model argues that optimal fertility diminishes when income increases because parents are incited to substitute quality to quantity. In this framework, two mechanisms can be at work. In the first one, supported by Becker & Lewis [1973], the income elasticity of demand for quality has to be higher than the income elasticity of demand for quantity. Indeed, as a first partial effect, because quality and quantity are assumed to be normal goods, both the demands for quality and quantity increase after the income shock. Furthermore, if the income elasticity of demand for quality is higher than for quantity, the increase in the demand for quality will be stronger than the increase in the demand for quantity. As a second effect, because of the non linearity of the parental budget constraint, a substitution effect takes place. When the demand for quality increases

more rapidly than the demand for quantity, the price of quantity finally increases relatively to the price of quality. Then, parents finally substitute quality to quantity.

The second mechanism implying a substitution of quality to quantity for higher levels of income lies in the nature of specific quantity costs. Mincer [1963] argues that child rearing is time consuming, especially for women. Willis [1973] uses this assumption in a simple model where parents decide to allocate their time between child rearing and participation to the labor market. This assumption has been largely adopted by subsequent literature (see, for instance, Galor [2005a]) and works very simply. Because child rearing is the most time consuming activity for families, a rise in labor incomes increases the cost of child rearing relative to the cost of quality and other commodities. Then parents reduce their fertility and invest more in the quality of each child.

The Beckerian representation of fertility behaviors has been challenged by Easterlin's theory. The Synthesis model of fertility is based on Easterlin [1978] and Easterlin *et al* [1980]. Rather than being in opposition to the Beckerian model, Easterlin tries to extent it. He accepts the representation of a rational family maximizing its utility subject to prices and income. He aims, however, at conciliating this framework with the demographers' model of supply for children and with the endogenous determination of preferences[52]. Incorporating the model of supply for children essentially consists in including new variables like the frequency of intercourse, infant mortality and disutility of constraints associated with contraception. This part of Easterlin's research proposal simply consists in a "natural" improvement of the Beckerian approach. Without using the Synthesis model, life-cycle models of fertility allow to represent optimal decisions on the timing of the first birth (see, for instance, Happel [1984] and Moffit [1984]) or optimal contraception and spacing

[52]Birdsall [1988] proposes an elegant modelization of the Easterlin's contribution.

between births[53]. An extensive literature modelizes the impact of child mortality on fertility choices without having recourse to the Synthesis model[54].

Endogeneity of tastes over fertility and commodities constitutes the real difference between Easterlin and Becker. In the Synthesis model, social norms are included as a determinant of parental utility. Preferences determine individual demands for commodities and children while social norms determine preferences. In the long run, norms and particularly fertility norms, change according to evolutions of the economic environment. For a given family in the short run, however, these norms are exogenous and constant.

Easterlin and successors failed in making the long evolution of social norms endogenous. This left the Synthesis model subject to the Becker & Stigler's critique : explaining the evolution of behaviors by changes in tastes provides "*endless degrees of freedom*" (1977, p. 89). As a result, the mainstream of the economic literature has adopted the Beckerian "purely economic" approach to represent fertility behaviors and their main evolutions.

[53]For instance, Heckman & Willis [1975] and Wolpin [1984] show that variations in the lyfe-cycle profile of parental income has an impact on the timing of first birth and on spacing of subsequent ones when access to capital market is restricted. They show that a rapid rise in familial income incites parents to postpone and space births. Indeed the services flows derived from children become less important relative to the labor income while childbearing remains costly.

[54]Sah [1991] and Kalemli-Ozcan [2003] propose a model where child mortality is a source of uncertainty for the success of the familial reproductive process. Because the number of surviving children is uncertain, parents tend to overshoot their optimal fertility target. In other words, they have a precautionary demand for children. One can reasonably question the assumption of uncertainty on the reproductive success. Indeed, infant death is assumed to arise at age one and child death at age five. It can reasonably and convincingly be assumed that the women fecundity period is long enough to ensure the replacement of dead children. Notice that this argument is no more valid if the mortality risk concerns young adult (see, for instance, Ehrlich & Lui [1991]). Another class of papers investigates child mortality without uncertainty (see, for instance, Barro & Becker [1988], Cipriani & Blackburn [1998], etc.). They find that a variation in child mortality changes the cost of quantity relative to quality. This effect will be further discussed in chapter 1.

3 Main Challenges of Modern Demographic Economics

After debating its foundations, the literature on fertility behaviors has begun addressing problems standard models were unable to answer in a satisfying way. Among these problems, the demographic transition and the welfare implications of fertility behaviors have emerged as the most fundamental issues to be addressed.

In section 3.1, I present the literature investigating the problem of optimal fertility behaviors. This literature tries to answer to three main questions: "How to define optimality when population is endogenous?", "What is, then, a good social welfare objective?" and "Why can individual fertility choices depart from optimality?" I show that, surprisingly, no study has analyzed the optimality properties of the seminal Beckerian model. Such a study, provided in Chapter 1, will highlight how the fundamental Beckerian model of fertility provides non intuitive recommendations of economic policy.

The starting point of the present introduction lies in declarations from Mr Al Gore and Mr Rocard who express fears toward respectively too high population growth rate in developing countries and too low population growth rate in developed ones. Fears about fertility behaviors are opposite for developing and developed economies essentially because they are not at the same stage of their demographic transition: developing countries have not completed their demographic transition yet while developed ones have.

The demographic transition is commonly defined as the transition from a high birth rate and high mortality rate regime to a low birth rate and low mortality rate regime. Section 3.2 investigates this phenomenon. I first provide, in sub-section 3.2.1, an overview of the standard economic explanations of the demographic trans-

ition. I show that these explanations are consistent with economic stylized facts but that they cannot reproduce the interplay between cultural and economic determinants of the long run decrease of fertility. Demographers, historians, sociologists and even anthropologists provide evidence that interactions between cultural and economic determinants of fertility are at the heart of the long run fall of fertility.

Usual models of fertility cannot reproduce this phenomenon essentially because it requires to recall the usual economists' assumption of exogenous and stable tastes. I show, in sub-section 3.2.2, that a recent economic literature has engaged in this general project. Using its fundamental findings, I propose a model (provided in chapter 2) where cultural transmission plays a critical role in fertility transitions.

The project of endogenizing cultural determinants of fertility benefits from the support of a recent empirical literature. This literature which I review in sub-section 3.2.3, investigates the impact of cultural variables like religion on individual fertility. It essentially shows that cultural variables can explain differences in individual fertility rates in a framework where Beckerian conclusions are also validated. I propose, in Chapter 3, a contribution to this literature for the case of France which has long suffered from a lack of data on culture and especially religion.

3.1 On the optimality of fertility behaviors

Welfare economics was born much earlier than modern endogenous fertility models. It aims at providing tools for "*judging the achievements of markets and policy makers in allocating resources*" (Besley [2003]). Welfare Economics was initially developed by neoclassical economists like Edgeworth [1897], Marshall [1920] and Pigou [1920]. They show that a social welfare function can be obtained as a sum of individual utility functions by assuming cardinal utility, decreasing marginal utility, stable and exogenous tastes and interpersonally comparable utility functions. The maximiz-

ation of the social welfare function under the resources constraint of the economy results in the first best equilibrium. Each deviation from market perfection, like externalities, will take the competitive equilibrium away from this social optimum. Then, Welfare Economics investigate the economic policies decentralizing the social optimum. The decentralization of the social optimum consists in the implementation of an economic policy which makes the competitive equilibrium coincide with the first or second best equilibrium.

With no limitation in the choice of instruments used to the decentralization, the first best social optimum can be decentralized. However, infeasibility of lump sum transfers and unobservability of some behaviors impose to restrict the set of instruments that can be used. In this case, only second best equilibria can be reached by economic policies (see for instance Atkinson and Stiglitz [1980]).

3.1.1 The concepts of optimality and social welfare when fertility is endogenous

How to define optimality when fertility is endogenous?

Applying the concept of optimality to demographic variables is not straightforward. The literature has widely evolved since the first approach by Samuelson [1975]. Samuelson assumes fertility to be exogenous and focuses on the optimal population growth rate in an overlapping generation economy. A famous debate took place between Samuelson [1975] and Deardorff [1976] about the true optimality of the "Goldenest Golden Rule". The "Goldenest Golden Rule" consists in the population growth rate which maximizes utility in steady state growth. Deardorff argues that, for any specification of the model where both the utility and production functions respect the Cobb-Douglas properties, the Samuelson's "Goldenest Golden Rule" consists, in reality, in "*a global minimum of steady-state utility, not a maximum*"

(Deardorff [1976]).

However, because fertility is not treated as a rational choice, this literature is not able to explain why actual fertility does not equal its golden rule level. Moreover, because the determinants of fertility behaviors are not elucidated, no recommendation for family policy can be made.

If the Beckerian contribution address the question of optimal fertility behaviors in a more satisfying way, it requires to refine the concept of optimality. Two recent contributions from Golosov *et al* [2007] and Michel & Wigniolle [2007] investigate the problem of Pareto efficiency with endogenous fertility. They argue that usual criteria have to be enriched when fertility is endogenous essentially because they do not take into account the welfare of unborn children. To compare Pareto efficiency of alternative equilibrium, one needs to compare utility that is distributed to the utility that could have been distributed with a different population size. In other words, as underlined by Golosov *et al*, the valuation of unborn agents who could have been born, has to be considered to determine the Pareto efficiency of an equilibrium. If some agents could have been born without diminishing utility of already born agents, an allocation is not Pareto efficient.

Then, what is a good social welfare objective?

When the Social Planner can choose the size of the population, answering to this question is not neutral for the final results. For instance, maximizing the total utility distributed (Benthamite utility function) can lead to very different results than maximizing the utility of the representative family (Millian utility function). Indeed, when the Benthamite utility function is chosen, the Social Planner exhibits a stronger preference for fertility than in the Millian case. For instance, Nerlove *et al* [1986] study the optimality of fertility behaviors in a framework where parents value

both the quantity and the well being of their offspring. They consider that parental utility positively depends on the consumption they allocate to their children. In this framework, they find that fertility, at the first best optimum, is higher when the Social Planner is Benthamite than when he is Millian.

Blackorby *et al* [2006] underline some caveats of both the *total utilitarism approach* (Benthamite objective) and the *average utilitarism* (Millian objective). On the one hand, they show that maximizing total utility can lead to the repugnant conclusion in which population size is maximal and average well being close to zero[55]. On the other hand, maximizing average utility implies that the *ceteris paribus* addition of an individual with a very low lifetime utility (even below neutrality[56]) is enjoyable as long as the existing population enjoys an even lower utility. To overcome these limitations, Blackorby *et al* [2005] investigate the concept of critical levels of utility which, if "*enjoyed by an added person without changing the utilities of the existing population, leads to an alternative which is as good as the original*". One major issue of this literature lies in the choice of critical levels.

Likewise, reminding that fertility is higher in the poorest families, assuming that the Social Planner is Rawlsian (maximin criterion) leads to higher optimal fertility rates than in the Millian case. For instance, Spiegel [1993] extents the Nerlove *et al*'s framework to a Rawlsian social planner. He shows that, despite its maximin objective, fertility at the laissez-faire equilibrium can be higher than at the Social optimum.

Once the concepts of optimality and social welfare explored, the reasons why

[55]They argue that "*a population principle implies the repugnant conclusion if every alternative in which everyone alive experiences a utility level above neutrality is ranked as worse than an alternative in which each member of a larger population has a utility level that is above neutrality but may be arbitrarily close to it*"

[56]Blackorby *et al* [2006] precise that "*a lifetime utility of zero represents neutrality. Above neutrality, a life, as a whole, is worth living; below neutrality, it is not. From the viewpoint of an individual, a neutral life is a life which is as good as one in which the person has no experiences*".

individual fertility behaviors can depart from optimality have to be elucidated.

3.1.2 On the sources of inoptimality

An economic behavior is inoptimal either if there exist a failure on the market where the good is traded or if this good is a source of externalities. Because of its nature, the quantity of children cannot be exchanged on a market[57]. Then, one can reasonably suspect that inoptimal fertility behaviors only come from externalities. So, along with refining the concept of optimality for fertility behaviors, the literature has investigated the externalities leading to inoptimal reproductive behaviors.

Such externalities are numerous. On the one hand, fertility can be a source of positive externalities and has to be promoted because, for instance: (*i*) it relaxes the budget constraint of a Pay-As-You-Go (PAYG) pension system. Groezen *et al* [2003] and Loupias & Wigniolle [2004] argue that children's marginal production will finance the pension system (*ii*) it increases the geopolitical and military power of the group (a nation or a specific group inside a population). For instance, investigating the Easter Island collapse, De la Croix & Dottori [2008] assume that, in the quest for greater bargaining power between opposite clans, the biggest group has the highest probability of winning the war (*iii*) it makes the emergence of new innovations more likely (see Jones [1999])

On the other hand, fertility can be a source of negative externalities because, for instance: (*i*) it intensifies the use of non renewable resources which raises the question of sustainability[58] (see D'Alessandro [2007], d'Albis & Ambec [2008]). De

[57] De la Croix & Gosseries [2008] propose a model where, to reach the optimal national fertility rate, a market of tradable procreation entitlements is implemented. In this case, fertility becomes a tradable good. However, inoptimality of fertility behaviors cannot come from imperfection on this market which ensures the government to reach the optimal national fertility rate.

[58] As expressed in the citation of Al Gore, the fertility of developing countries is a major concern for sustainability. Because populations of developed countries have already achieved their demographic transition, the reduction of their fertility cannot be considered as a solution to reduce

la Croix & Dottori [2008] argue that, if higher fertility increases the group's power in the threat of war, it can lead to a population race continuously inciting group to increase their size. Then, an over-population and an over-exploitation of resources can appear and lead to collapse. (*ii*) it increases the probability of epidemic disease (see, for instance, Dasgupta [1993]) (*iii*) it creates free-rider problems in community where child rearing is cheap (because of child labor for instance) and local resources are owned communally (weak definitions of property rights). Dasgupta [2000] provides enlightening evidence for this externality in poor countries.

If there exists a large literature on externalities coming from fertility behaviors, surprisingly, no study investigates the optimality of the trade-off between quality and quantity in the seminal Beckerian framework. One could argue that determining the recommendations of economic policy of this basic framework is somewhat useless because of the model's lack of realism. It is obvious that the numerous refinements of the endogenous fertility model allow to address precise problems (as previously mentioned) which are well beyond the scope of the initial Beckerian model. This literature can be divided into two groups: models uniquely including endogenous fertility without quality[59] and models making the trade-off between quality and quantity endogenous.

I argue that the conclusions of models which ignore the quality dimension of fertility behaviors are relatively incomplete. Indeed, because of the non linearity of the parental budget constraint, nothing ensures that "optimal policies" taxing or subsidizing births or parental incomes in models without quality, do not unoptim-

the use of natural resources. However, fertility rates in developed countries can be decreased. If there is little doubt, for demographers, that all developing countries will experience a demographic transition, the question of its pace is fundamental for sustainability. Indeed, once fertility has decreased, the population goes on experiencing a rapid growth because the number of women in age to procreate increases (this is called the momentum). If the decrease in fertility rates occurs too late, the world population could stabilize at a level which does not ensure sustainability.

[59] See, for instance, Fraser [2001] and Ab *et al* [2004].

ally distort parental spending on children's education, health, etc. So, the conclusions of models which do not include the quality dimension of fertility behaviors are weakened.

Balestrino *et al* [2000], Cigno & Pettini [2002], Nerlove *et al* [1986] and Spiegel [1993] investigate optimal family policies in a framework of trade-off between quality and quantity. However, Balestrino *et al* [2000] and Cigno & Pettini [2002] focus on specific problems of optimal income tax in presence of mimicking problems and on heterogeneity in abilities to raise children. Nerlove *et al* [1986] and Spiegel [1993] investigate optimality of fertility behaviors in a static model with only two periods.

Studying the implications of the fundamental non linearity in the costs structure of the quality-quantity problem would clarify the conclusions of the economic literature exploring optimality of fertility behaviors. I propose this study in the first chapter of the present thesis. In this chapter, I argue that there is a general consensus in the economic literature and in economic institutions about the legitimacy of policies subsidizing education. This legitimacy lies in the fact that education is a source of positive externalities. In the standard Beckerian framework, I show that this result is still valid but that subsidizing education also requires to implement a policy on births. This policy will consist in taxing births for a large set of Social Welfare functions. Indeed, education subsidies decrease the net cost of children such that parents can exhibit a too high fertility rate.

In an extended version of the model, I make child mortality endogenous: parents can invest in health expenditure to reduce the children mortality they face when they choose their optimal trade-off between quality and quantity. In this framework, health consists in another source of externalities because average health status in the population reduces the probability of disease (see, for instance, Dasgupta [1993]). I

show that, even though parents do not invest in their children's health enough at the competitive equilibrium, health expenditure should not always be subsidized. Indeed, the taxation of births plays the role of an indirect subsidy on health expenditure because it decreases the cost of health relative to the cost of children's quantity. As a result, when externalities on education are very high relative to positive externalities on health, the tax on births is strong and so, the indirect subsidy on health can exceed the subsidy that is really needed. Then health expenditures have to be taxed.

Finally, the first chapter of this thesis shows that the standard Beckerian model of fertility provides non intuitive recommendations of economic policy. I also make clear that studying optimal fertility problems without considering the quality dimension of the Beckerian model leads to weakened conclusions. Considering children's quality as human capital has also been favored by the literature to analyse the demographic transition.

3.2 Demographic Transition: toward the Easterlin's come back?

A large majority of countries have already experienced their demographic transition. Furthermore, demographers expect that mankind will have achieved it at the end of the century. In Early European Countries as in the rest of the world, the average annual growth rate of population was close to 0,1% between the years 0-1820 (Maddison [2003]). When Western Europe and United States entered the demographic transition, the population growth rate became higher and reached an average annual growth rate of 0,8% between 1870-1913. The late entrance of less developed countries in the demographic transition increased this demographic growth up to 1,92% during the period 1950-1973.

Western Europe entered the demographic transition at the turn of the nineteenth century (see figure 1[60]). England and France were the first countries to experience the fertility transition (see figures 2 & 3), that is to say a long run decline in their fertility rates.

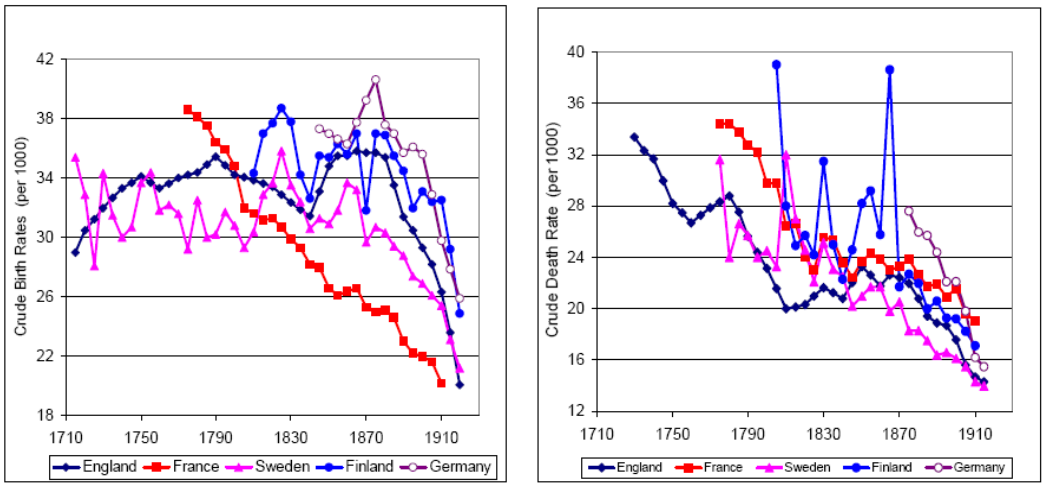


Figure 1: The Decline in Fertility and Mortality in Western Europe
Source: Andorka (1978)

In the following sub-section, I provide an overview of the standard explanations of the demographic transition by economists.

3.2.1 Traditional Analysis of the Demographic Transition

Demographers have long argued that the decline in mortality and especially in infant and child mortality has been the main engine of the long run decrease in fertility[61]. Due to major improvements in hygiene and sanitation, infant and child mortality have rapidly fallen. Then parents needed to give birth to less children in order to reach the same number of surviving children. The time lag between the decrease in

[60] Graphics from Galor [2005a].

[61] Some economists have also explored this channel. See, for instance, Kalemli-Ozcan [2003] and Eckstein *et al* [1999].

mortality and fertility[62] is then presented as a progressive adaptation of reproduction behaviors to the mortality decline (see, for instance, Henry [1976]).

This explanation is, however, counterfactual. For instance, Fernandez-Vilaverde [2004] proposes a quantitative analysis where the decline in mortality is insignificant to explain the fall in fertility rate during the demographic transition. Another example lies in Doepke [2005] for England between 1861 and 1951. He finds that the reduction in infant mortality was not the engine of the net fertility decline during the demographic transition characterizing this period. Furthermore, demographic transitions of France (see figure 3) and United States also constitute counterexamples because, in these countries, fertility began to fall well before mortality.

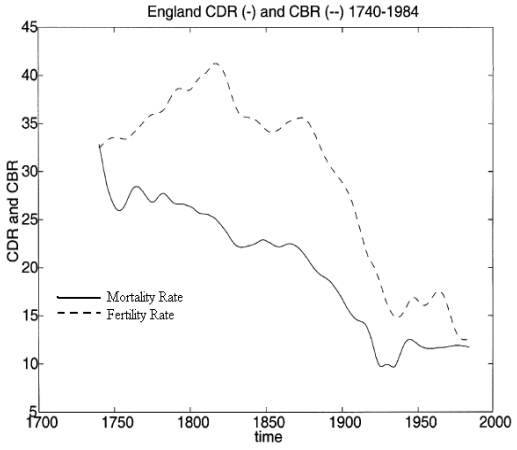


Figure 2: English Fertility Transition

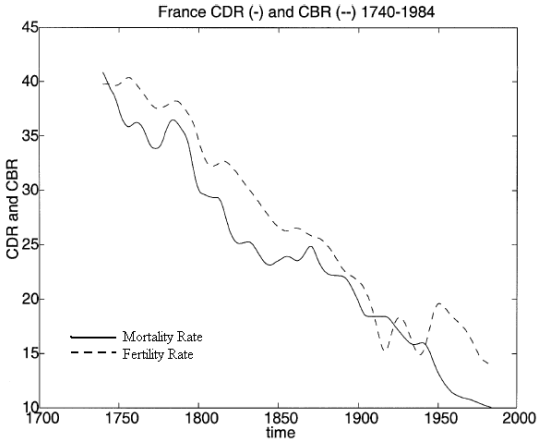


Figure 3: French Fertility Transition

Becker [1981] claims that the decrease of fertility rates has been provoked by a rise in incomes. As previously explained, in the Beckerian framework, a rise in income makes fertility decline because opportunity costs of raising children increase (children are time consuming) and because the income elasticity of demand for

[62] Notice that once fertility has converged to his low long run value, the population growth rate will remain high for several periods. This is called the population momentum. It can be defined as "The tendency for population growth to continue beyond the time that replacement-level fertility has been achieved because of the relatively high concentration of people in the childbearing years." (Institut National d'Etudes Démographiques).

quantity is lower than the income elasticity of demand for quality.

Galor [2005a, 2005b] argues that two main explanations for the decrease of fertility during the demographic transition fit the facts[63]. In the first one, Galor & Weil [1996] state that the technological progress characterizing the Industrial Revolution reduces the gender wage gap because it reduces the complementarity between capital and physical force. It makes the costs of child rearing (mainly supported by women[64]) increase relative to the cost of education. Parents finally tend to make less children and to provide them more education.

The second explanation comes from Galor & Weil [1999] and gave birth to the so called Unified Growth Theory[65]. They explain the emergence of the Industrial Revolution and the Demographic Transition by an increase in the rate of technological progress. This acceleration of technological progress comes from a scale effect: a latent population growth gives birth to a latent technological progress. Technological progress makes both the parental income and the return to investment in children's human capital increase. Initially, returns of investments in children's human capital are not sufficient to incite parents to invest in their children's education, then parents increase their fertility as they are wealthier (positive income effect). When the technological progress has reached a threshold, investment in children's education becomes profitable and parents substitute quality to quantity. An endogenous technological progress takes place and pushes the economy toward a long run path

[63] These explanations are also discussed in Chapter 2.

[64] Galor & Weil consider a unitary household decision model, that is to say a model where a couple finally acts as if it was a single agent. The literature on household decision models has proposed an alternative representation: the collective model (see Bourguignon *et al* [1995] for a review of this literature). It assumes that a household's behavior results from a negociation process between each spouse. In other word, contrary to the unitary model, it does not behave like a benevolent dictator. This literature enriches some fundamental results of the Beckerian model. For instance, it underlines the fact that fertility is negatively related to women's income while the reverse is true for men. This literature allows to investigate questions like gender discrimination (see, for instance, De la Croix & Vander Donckt [2008]).

[65] Galor [2005a] provides a complete and enlightening presentation of this literature.

of economic growth where fertility converges to a low long run steady state. This model fits the stylized facts of both the Industrial Revolution and the demographic transition.

A large literature has completed the seminal approach of Galor & Weil [1999]. It explores mechanisms which reinforce the conclusions of Galor & Weil. For instance, Hazan & Berdugo [2002] argue that the technological progress lowers the optimal number of children because it increases the wage gap between children and adults. Then, the rise in the return to investments in children's education are reinforced. Other reinforcing mechanisms lie in: (*i*) the rise in life expectancy which also increases the return to education investments[66], (*ii*) the old-age security assumption (see Ehrlich & Lui [1991]) and (*iii*) the role of luck (see Becker *et al* [1990]).

De la Croix & Doepke [2003] propose a model where differential fertility matters for the long run relationship between inequality and growth. They find that stronger inequalities between riches and poors slacken growth and development because poor people have a higher fertility than riches. They invest less in education than riches, their proportion increases which lowers the average level of human capital in the society. Finally, stronger inequalities delay the fertility transition and reduces growth.

If all these contributions provide consistent explanations for the demographic transition, they cannot take into account one major determinant of the long run decrease in fertility: interactions between economic and cultural determinants of fertility.

The role of cultural factors in the European demographic transition has been largely evidenced by demographers, historians, sociologists and even anthropolo-

[66] See, for instance, Hazan and Zoabi [2005], Moav [2005]

gists[67]. For instance, demographers from the Princeton Project (see Coale & Watkins [1986]) highlight the fact that the demographic transition in Early Western Europe originates from the interaction between an economic and a cultural transition. Such a cultural transition has made births control acceptable[68]. Lesthaeghe [1986] also provides enlightening evidence that the evolution of Catholicism has been decisive to the long run decrease of fertility in Western Europe.

Studying the case of Sub-Saharan Africa, Dasgupta [2000] argue that conformity toward ancestral cultural values can partly explain the persistence of high fertility rates. He interestingly mentions "*the possibility that traditional practice is perpetuated by conformity. Procreation in closely-knit communities is not only a private matter, it is also a social activity, presumably influenced by both family experiences and the cultural milieu. Formally speaking, conformist behavior would occur if every household's most desired family size were an increasing function of the average family size in the community (Dasgupta, 1993). This is, of course, a 'reduced form' of the concept, and the source of a desire to imitate could lie in reasons other than an intrinsic desire to be like others*".

Following Knodel [1988], a large literature proposes country dependent and even county dependent studies in order to take the cultural dimension into consideration[69] (see, for instance, Assve et Altankhuyag [2006] and Zachariah [2006]).

To modelize the role of interactions between economic and cultural determinants of fertility, it is necessary to renounce to the assumption of stable and exogenous preferences. Dealing with non constant preferences is not usual for economists. A

[67] Anthropologist demographers argue that the evolutions in the distribution of genetic or cultural traits can explain the demographic transition. See, for instance, Bergstrom & Stark [1993] and Fricke [1997].

[68] These results will be further discussed in Chapter 3.

[69] Hammel [1990] and Mason [1997] criticize the continuing localization of demographers' studies on the demographic transition. They argue that the strong local aspect of these literature prevents the validation of a general theory for the demographic transition.

recent literature proposes general frameworks to make preferences and their transmission endogenous. The following sub-section provides a brief overview of this literature. In line with this literature, I propose a model (provided in Chapter 2) which gives a role for cultural transmission in fertility transitions.

3.2.2 Culture and endogenous preferences

Making preferences and their transmission endogenous[70] is a necessary condition to modelize the interactions between economic and cultural determinants of the long run decrease of fertility.

A first way to modelize the interaction between cultural and economic variables comes from Duesenberry [1949], Blomquist [1993], Lindbeck [1995], Lindbeck *et al* [1999] and Palivos [2001]. They make social norms and culture endogenous by defining norms as a function of average behaviors. Doing so, the evolution of norms is driven by individual choices which are, in turn, determined by current social norms. Notice that Palivos and Lindbeck do not deal with heterogeneity in preferences. They are not interested in representing the distribution of preferences into the population and the transmission of norms through generations.

Doepke & Zilibotti [2008] propose a model where parents can invest in their children's patience and taste for work. Doing so, the dynamics of preferences is endogenous: it is increasing in both the parental investment and the parental "stock" of patience and taste for work. Then, Doepke & Zilibotti relate the Industrial Revolution to this transmission of preferences among families and to the development of financial markets.

Evolutionary approaches provide another way of making preferences endogenous (see Bergstrom [1996] for a review of this literature). One major contribution comes

[70] To avoid independent cultural explanations, Becker & Stigler [1977] present culture as a rational choice made by agents maximizing their utility.

from Galor & Moav [2002] who assume the existence of alternative genetic groups in the population, namely the quantity-type agents and the quality-type one's[71]. At the scale of the whole population, differential fertility between the two groups shapes the evolution of preferences: the group with the highest fertility becomes majoritarian and greatly influences the average preference in the society.

Including evolutionary processes allows to relax the stability of preferences without falling under the Becker & Stigler's [1977] critique that explaining fertility behaviors by changes in tastes gives "*an endless degree of freedom*". Indeed, the interplay between economic and evolutionary conditions provides an explanation for the change in taste for children. A limitation of this evolutionary explanation lies in the fact that only differential fertility matters to explain the long run evolution of preferences. It prevents from addressing other important issues like the influence of culture, social norms and social institutions[72].

Bisin & Verdier [2001] propose a framework making the cultural transmission and the dynamics of preferences endogenous[73]. They posit that the transmission of preferences from parents to children is not perfect because it is cultural rather than genetic. Parents have to provide a socialization effort in order to transmit their preferences to their children. If they fail, their children will be socialized by the society. This framework allows to make the long run evolution of preferences endogenous: it results from the interaction between the economic and cultural behaviors of agents and the population's cultural composition.

The second chapter of the present thesis is dedicated to the elaboration of a

[71] This assumption is nicely evidenced in Galor & Moav's paper which is further discussed in the second chapter.

[72] Another important limitation of the Galor & Moav's framework lies in the impossibility for a genetic group to disappear. Indeed, optimal fertility is never equal to zero and no mobility between groups is possible. The impossibility of a group disappearance is somewhat counterfactual for evolutionary processes.

[73] This framework is further presented in Chapter 2.

fertility model in which the interaction between economic and cultural variables explain the long run decrease of fertility. In a framework à la Bisin & Verdier [2001], I define alternative cultures following their members' preferences for quantity of children[74] and their mode of production. Because the preference for children is cultural rather than genetic, its transmission is not assumed to be perfect. In other words, I allow for mobility between cultural groups that makes their disappearance possible. Furthermore, the long run evolution of average preferences in the whole population is not driven only by differential fertility but also by differential parental efforts of cultural transmission.

More precisely, differential fertility between cultures gives rise to an evolutionary process while differential effort to transmit the parental culture gives rise to a cultural process. The long run distribution of preferences and the average total fertility rate in the population both result from interactions between these two processes. As a result, a fertility transition cannot appear without productivity shocks in favor of the culture which is not biased toward quantity of children. However, these asymmetric productivity shocks are not always a sufficient condition to undergo a fertility transition. According to findings of demographers like Lesthaeghe [1986], this model allows to reproduce, at least, the impact of Catholicism and Calvinism on the fertility transition in Early Western Europe[75].

Because it assumes that fertility is partly determined by social norms, this model incorporates some pieces of Easterlin's Synthesis model. However, because the long run evolution of norms at the scale of the whole population is endogenous, it does not fall under the scope of Becker & Stigler's critique.

[74] This assumption finds common features with the Galor & Moav's [2002] one. I, however, provide evidence, in chapter 2, in favor of cultural determinants to alternative valuation of children's quantity. I notably focuse on religious variables.

[75] This will largely discussed in Chapter 2.

Above the evidence underlined by demographers and sociologists, the inclusion of culture as a determinant of population dynamics finds another support in a recent empirical literature. This literature investigates the impact of cultural variables, and especially religion, on fertility behaviors in a framework where the Beckerian conclusions are validated. The following sub-section presents this literature and describes the third and last chapter of the present thesis which provides a contribution to this literature by studying the impact of religion and cultural transmission on individual fertility in France.

3.2.3 On the empirical validation of the importance of culture and religion

Modern economists have recently engaged in investigating the impact of culture and norms on economic behaviors. Thanks to the development of rich datasets including a large number of variables which proxy for culture, they are now able to properly discriminate between cultural and non cultural variables and to test causality between culture and economic behaviors[76].

Fernandez & Fogli [2007] have recently provided a major contribution to the investigation of the relationship between fertility behaviors and cultural variables. They succeed in approximating culture with "purely economic" variables. They show that national culture of female immigrants to United States during the twentieth century has a significant impact on their fertility and their participation to the labor market. They approximate the cultural attitude of immigrants toward fertility and labor supply with the average fertility and average female participation to the labor market in the immigrant's country of origin (epidemiological approach; also see Fernandez & Fogli [2006]). They find that, all other things being equal, the

[76] Guiso *et al* [2006] provide an enlightening review of this vast literature.

average fertility in the country of origin has a positive and significant impact on the immigrant's fertility.

Another favored way to measure the impact of culture on fertility behaviors consists in measuring culture with religious variables. This method has long been used by demographers and sociologists. Economists did not really used it because available datasets did not include sufficiently satisfying economic variables. Modern econometrics make clear that studying cultural variables omitting fundamental economic variables would consist in a spurious challenge. Nevertheless, recent datasets include both economic and religious variables. For instance, Adserá [2006] and Brãnas-Garza & Neuman [2006] find that, all usual economic determinants controlled for, the intensity of religious practice has a positive and significant impact on fertility[77].

The third chapter of the present thesis contributes to this growing literature via an econometric study of the impact of religion and cultural transmission on individual fertility in France. Usual microeconometric studies of the French fertility suffer from the lack of data on religion. Indeed, the French laws make it very difficult to collect data on individuals' religious affiliation. Chapter 3 constitutes the first attempt to measure the impact of religion on French fertility behaviors in a framework where usual Beckerian effect are controlled for[78].

My results show that having been raised in a religious family has no significant effect on fertility and considering oneself as a believer does not matter either. However, religiousness, whatever the measure that is chosen, has always a positive and significant impact on expected fertility. This effect is measured in two ways.

[77] A review of this literature is provided in Chapter 3.

[78] Prioux & Régnier-Loilier [2008] discuss the impact of religious affiliation on fertility in France. However, their study is not quantitative and they do not consider economic variables as potential determinants of fertility behaviors.

First, as in the usual literature, I approximate the intensity of religious practice by attendance to religious office. Second, I propose a new and alternative measure for the degree of religiousness: the respondent's estimation, between zero and ten, of the importance of religion in his own life.

This chapter also validates usual predictions of family economics. The income of the male has a positive impact on woman's fertility while the woman's own income has a negative impact on her fertility. Moreover, the school attainment of women has a negative impact on their expected number of children. Finally, in line with recent studies of Adserá [2006], Fernandez & Fogli [2007], Braenas-Garza & Neuman [2006], I provide empirical evidence in favor of the inclusion of endogenous cultural mechanisms in fertility models.

The rest of the present thesis will be composed of the three chapters I have briefly presented in the third part of this general introduction, and of a general conclusion.

Chapter 1

Family Policies: What Does The Standard Endogenous Fertility Model Tell Us?

Introduction

There is a general consensus in the economic literature and in economic institutions about the legitimacy of policies subsidizing education. This legitimacy lies in the fact that education is a source of positive externalities [Hanushek & Welch (2006)]. In this paper, I use the standard framework of *endogenous fertility with a trade-off between quality and quantity.* I show that this result is still valid but that subsidizing education can also require taxing births[1] for a large set of Social Welfare functions including Benthamite and Millian[2] objectives. Indeed, education subsidies decrease the total cost of children such that parents can have too much children.

Following this result, health is introduced as another source of positive externalities reducing child mortality. Despite these positive externalities, health expenditure should not always be subsidized: at the laissez-faire equilibrium, parents do not invest enough in their children health but the taxation of births plays the role of an indirect subsidy on health expenditure. Indeed taxing births decreases the cost of health relative to the cost of the quantity of children. As a result, for small externalities on health, the indirect subsidy can be higher than the subsidy that was required to reach optimality, then health expenditure has to be taxed.

The "standard framework" of endogenous fertility comes from the seminal works of Becker *et al.* [1973,1976,1988]. It consists in a model where parents value the number of their offspring (quantity) as well as their future human capital (quality). They maximize their expected utility subject to a non linear budget constraint[3].

[1] Notice that, in this paper, family policies are limited to tax - transfer policies. In reality, familiy policies include a large set of instruments like, for instance, coercive policies and preventive actions.

[2] A Millian social welfare function consists in the average utility of the representative agent while a Benthamite social welfare function value the total utility distributed in the economy. Blackorby *et al* [2006] provide an enlightening discussion on the caveats of these two welfare functions.

[3] This non linearity is fundamental in models of trade-off between quality and quantity. Because quality is provided to each child (with or without equity), its cost crucially depends on the quantity

Then a trade-off between quality and quantity takes place. This fundamental contribution of Becker has been followed by the major improvements of Galor *et al.* [1999, 2002], De la Croix & Doepke [2003], Kalemli-Ozcan [2003], etc., resulting in a unified framework. Surprisingly, there are very few studies exploring the optimality properties of the trade-off between quality and quantity in this unified framework. The question of optimal fertility has been studied in other models.

On the existing literature

Samuelson [1975], Deardorff [1976] and Michel & Pestieau [1993] address the question of the optimal population growth rate in an overlapping generation model with exogenous fertility.

Michel & Wigniolle [2007] and Golosov *et al.* [2007] focus on the Pareto optimality of equilibria when fertility is endogenous. They show that usual criterion for Pareto optimality is not appropriate when the size of populations is a choice variable. They, however, do not deal either with the quality-quantity trade-off or with the question of optimal family policies.

Boulding [1964] proposes implementing a market of tradable procreation rights. This idea is explored by De la Croix & Gosseries [2007]. It finally consists in a system of tax or subsidy on the quantity of children. They do not investigate, however, the reasons why governments are not satisfied with their national fertility. Then, the present paper can be considered as a complement to this literature.

In a model of endogenous fertility, Groezen *et al.* [2003] deals with the question of optimal family policies. He argues that, in the presence of a Pay As You Go (PAYG) pension system, children are a source of positive externalities because their marginal production will finance the pension system. It implies that the competitive

choices. Then the parental budget constraint is no longer linear.

fertility rate is too low, and so a child allowance has to be implemented[4]. However, if there is no PAYG pension system, the competitive fertility is optimal. Notice that Groezen *et al.* do not deal with the trade-off between quality and quantity, it partly causes this last result.

Nerlove *et al* [1986] study the optimality of fertility behaviors in a framework where parents value both the quantity and the well being of their offspring. They consider that parental utility positively depends on the consumption they allocate to their children[5]. In this framework, they find that subsidizing births can be an optimal fiscal policy when the social welfare function is Millian. Conversely, when the Social Welfare function is Benthamite, they find that the optimal economic policy always consists in a child allowance[6]. These results sensibly differ from mine because they are obtained in a finite horizon problem with only two periods. Furthermore, Nerlove *et al* do not assume the existence of externalities in the production of children's quality. Doing so, they do not really deal with the intergenerational inefficiencies of the parental trade-off between quality and quantity.

My paper is more closely related to the contribution of Balestrino *et al* [2000]. They deal with optimal fiscal schemes when there is a trade-off between quality and quantity in an infinite horizon framework. They assume that parents are heterogenous in their ability to raise children. Parental choices are all Pareto efficient. However, the government is characterized by a Benthamite function of Social Welfare and faces a mimicking problem à la Stiglitz (the workforce participation is not observable). Fertility being observable, taxing births can help the government to dif-

[4] In a closed framework, Loupias & Wigniolle [2004] show that a generalized Allais-Samuelson-Diamond golden rule can be reached only if fertility is subsidized.

[5] They also propose alternative formulations which will be mentionned in the rest of the paper.

[6] Spiegel [1993] extends the Nerlove *et al*'s framework to Rawlsian social preferences. He shows that a poll tax on births enables the government to decentralize the social optimum of the economy. This instrument is, however, a perfect substitute for a tax on the second period consumption.

ferentiate parents who are really poor from mimickers. Another contribution comes from Cigno and Pettini [2002] who find a similar result without mimicking problems.

On the paper's contributions

In the present paper, an alternative approach to Balestrino *et al* [2000] is proposed. The necessity of tax - transfer on births is not conditional either on the existence of differences between the government's objective[7] and parental preferences or on a problem of unobservability of behaviors[8]. Indeed, the implementation of birth tax or child allowance comes from both the existence of externalities in the human capital accumulation process and from the non linearity of the parental budget constraint with regard to quality and quantity. These two features are common to the largest majority of papers dealing with the quality quantity trade-off[9]. Departing from the Millian Welfare function or adding alternative externalities will enrich the analysis[10]. However, it will never affect my main mechanism because this mechanism results from the fundamental assumptions of the usual theory of endogenous fertility.

As previously mentioned, the model's main assumption is the existence of externalities in human capital accumulation. When parents choose their optimal trade-off between quality and quantity, they do not consider that their education investment

[7]Indeed, I also obtain this result when the Social Planner is Millian, that is to say when he is characterized by the same objective as the representative parent.

[8]In Balestrino *et al* [2000], even if the social planner dislikes welfare inequalities, the observability of abilities would make the individual indirect utilities observable. Then lump sum transfers would ensure an optimal redistribution of welfare. No tax on births would be required.

[9]See, for instance, Galor *et al* [1999, 2002], De la Croix & Doepke [2003], Kalemli-Ozcan [2003], etc.

[10]For instance, I assume that there is no inequalities in term of wealth or abilities between agents. So, educational policies do not find their legitimacy in the governement willingness to reduce inequalities. In reality, the reduction of inequalities is a major motivation to implement educational policies. However, in the present framework, I do not need to introduce inequalities to obtain my results. Doing so would only enrich the model. Behaviors being observable, the presence of inequalities would require to implement additional transfers between families.

will improve the overall efficiency of the human capital accumulation process. It implies that, at the laissez-faire equilibrium, they tend to under-invest in education and to have too much children.

My aim is to determine the tax-transfer policy that will decentralize the social first best optimum. Such an exercise is very usual in the public economic literature, it consists in determining distortions ensuring that decentralized individual decisions lead to the social optimum. In the present framework, I apply this standard methodology to a non standard problem. Indeed, quality and quantity of children are special goods which cannot be exchanged on a market[11].

Intuitively, because there only exist externalities on the accumulation of human capital, one can expect that a subsidy on education spending will be enough to decentralize the social optimum. Nevertheless, I argue that, in this framework, the first best social optimum cannot be decentralized with less than two pigouvian taxes[12] and one lump sum transfer. These pigouvian taxes consist in a subsidy on education expenditure and a tax or a subsidy on births. Such a result comes from the parental budget constraint in which quality and quantity enter multiplicatively. This non linearity implies that distorting the cost of quality to correct human capital externalities distorts, in turn, the total cost of quantity: children become cheaper. Then a tax on child births has to be implemented to correct this second distortion.

This central result is robust to the introduction of a "natalist bias" in the social

[11] I assume that the government can observe the agent's behaviors, it allows to decentralize the first best social optimum. This assumption is strong but fundamental because it shows that the standard problem of trade-off between quality and quantity (externalities on human capital and non linearity of the parental budget constraint) structurally generates inoptimal laissez faire equilibria *regarding both education and fertility choices*. Adding alternative externalities on fertility or studying second order optima will interestingly contrast this result.

[12] Notice that, as in Nerlove *et al* [1986], I only focus on non coercive policies and on linear taxation. Without inqualities, focusing on linear taxation is not a strong assumption because redistribution is not a matter of concern. Fan & Stark [2008] consider the impact of heterogeneity on welfare and policy analyses.

planner's preferences (the Benthamite utility function will be a special case of "natalist bias") and to the extension to endogenous child mortality. Notice that, when the Social Planner exhibits a strong natalist bias, the optimal policy will consist in subsidizing education and child births.

Examples of taxes on births are very numerous. In developed countries, these taxes are negative and consist in family allowance policies. Laroque & Salanié [2005] find that this policy is responsible for relatively high fertility rates in France. Among developing countries, China explicitly implements taxes on births, this example will be further discussed in the following sections.

The introduction of endogenous child mortality is an important extension of this framework because it changes the nature of the trade-off between quality and quantity. Indeed, now parents do not only have to decide how to allocate their spending between quality and quantity, they also have to decide their optimal strategy to reach their desired number of children. In other words, they face an alternative trade-off between quality and quantity of surviving children in which their health expenditure will be a source of externalities.

In the extended model, higher parental health expenditure reduces child mortality. Furthermore, the average level of health spending has a negative impact on child mortality. The literature of development economics provides strong evidence that overall health quality is one of the main determinant of individual health quality. For instance, Dasgupta [1993] shows that 45 per cent of all deaths in developing countries can be imputed to infectious and parasitic diseases. Private health expenditure helps reduce the probability of being infected when an agent is in contact with diseases. So a higher average level of health expenditure reduces death probabilities in all families. This positive externality implies that private health expenditure is too

low at the competitive equilibrium.

Here, I only consider the Millian case for simplicity. Reaching optimality requires, once again, subsidizing education and taxing births. Now, the taxation of births plays the role of an indirect subsidy on health expenditure. Indeed, it increases the cost of quantity relative to the cost of health. To reach the same number of surviving children, parents tend to increase their health expenditure and to give birth to less children. For strong externalities on health expenditure, the indirect tax will not be sufficient to reach optimal health expenditure at the competitive equilibrium. So private health expenditures have to be subsidized[13].

The recommendation to tax births in complement to subsidies for education and health, can be analyzed in the light of some empirical evidence from China and Sub-Saharan Africa. They both face a problem of overpopulation and implement alternative strategies to reduce fertility. My paper's results are obviously theoretical and cannot reproduce the very complex demographic, economic and political conditions of these countries. However, it provides some incentives to put into questions their strategies.

China is experimenting with a specific fiscal scheme on births which subsidizes the first birth and strongly taxes subsequent ones. However, empirical studies such as those of Kanbur & Zhang [2005] and Fan & Zhang [2000] show that investment in education and health is insufficient in China. The present paper proposes an alternative fiscal scheme that would reallocate public funds from the first birth subsidy to the promotion of education and health, without, *a priori*, loss of efficiency in birth control.

Sub-Saharan African countries have implemented several family planning pro-

[13]Once again, I focuse on linear taxation. Notice that I do not deal with health as a pure public good. Doing so would make less plausible that taxing health expenditure is optimal.

grams which strongly promote investment in health and education. However, a recent report of the World Bank [2007] shows that this policy has been inefficient in reducing the net fertility rate in a large majority of these countries. As shown in this paper, one reason why these policies have been inefficient could lie in the fact that they did not increase the relative cost of quantity. It shows that more attention should be paid to the implementation of a fiscal scheme that would explicitly sanction births.

The rest of the paper is organized as follows. In Section 2, the benchmark model is presented. Its recommendations in terms of family policies are discussed. In Section 3, endogenous child mortality and public health expenditure are introduced. Section 4 discusses the paper's empirical implications for China and Sub-Saharan Africa. Section 5 concludes.

1 The Benchmark model

1.1 The Competitive Equilibrium

The model consists in an overlapping generation economy with L_t agents who live for two periods: childhood and adulthood. During childhood, an agent receives education from his parent and does not consume. When he becomes adult, he has to choose his consumption level C_t, the number of his children N_t and their education e_t. For simplicity, families are monoparental. Parents exhibit altruism for their children in the sense that they value their future human capital[14]. The

[14]I do not consider altruism going from children to parents as, for instance, in Erhlich & Lui [1991] and Belan & Wigniolle [2007]. Nerlove *et al* [1986] argue that, in this case, children and capital markets are substitute because children's altruism ensures their parent to receive support in their old age. Then, a policy introducing more efficient capital markets can make fertility decreasing.

parental utility function is denoted:

$$u_t = U\left(C_t, \xi N_t, h_{t+1}\right) \tag{1.1}$$

$U(.,.,.)$ is strictly increasing and concave in its arguments[15]. N_t denotes the number of children born in the family and $\xi \in]0,1[$ the fraction of children who survive to age five. I assume that parents value the number of surviving children and not the number of children born. It implies that child mortality is a source of disutility. ξ is exogenous in this section but will be thereafter endogenized. There is no uncertainty about the reproductive success of a family[16].

Finally, h_{t+1} denotes the human capital in $t+1$ of an adult born in t[17]. Following De la Croix & Doepke [2003], parents finance a schooling time e_t and the average human capital of teachers equals the average human capital in the population. There is also an intrafamily transmission of human capital: the human capital of parents h_t positively influences the future human capital of children. Because parents do not decide their own human capital level, the transmission of human capital into the family is an externality. Moreover, the average level of human capital in the population has a positive impact on the children's future human capital. This second externality represents the influence of the efficiency of the school system ($\overline{h_t}$ is the teachers' productivity) and the presence of peer effects. Human capital is

[15] Alternative representations of utility could have been chosen like: $U\left(C_t, \xi, N_t, h_{t+1}\right)$ or $U\left(C_t, \xi N_t h_{t+1}\right)$. As it will become clear in the following sections, these alternative specifications would lead to exactly the same results.

[16] So, unlike the models of Sah [1991] and Kalemli-Ozcan [2003] which assume uncertainty, parents will not overshoot their number of children to ensure the compliance of their optimal fertility rate. Because child death is assumed to occur before age five, parents can rapidly ensure the replacement of dead children.

[17] As in Becker [1976], Galor *et al* [1999,2002], De la Croix & Doepke [2003] and Kalemli Ozcan [2003] the paper assumes that parents directly value the future human capital of their children. They do not value their future well being. In other words, altruism is limited to one generation.

accumulated through the following process[18]:

$$h_{t+1} = l\left(e_t, h_t, \overline{h_t}\right),\ l'_1 > 0, l''_{11} \leq 0, l'_2 > 0, l''_{22} < 0, l'_3 > 0, l''_{33} \leq 0, \qquad (1.2)$$

The function l is strictly increasing and concave regarding educational investment. Note that, following equation (1.2), e_t can be expressed as a function of h_t, $\overline{h_t}$ and h_{t+1} such that: $e_t = e\left(h_{t+1}, h_t, \overline{h_t}\right)$ and $e'_1 > 0$, $e'_2 < 0$, $e'_3 < 0$.

The maximization of utility is subject to the following budget constraint:

$$C_t + \left[\frac{\sigma}{\xi} + \phi\right] w_t h_t X_t + \theta w_t \overline{h_t} \Omega\left(X_t\right) \cdot e_t = w_t h_t \qquad (1.3)$$

$X_t \equiv \xi N_t$ denotes the number of surviving children at the end of period t. Each child born takes a part $\sigma \in]0,1[$ of its parent's time allocation that is normalized to one. Moreover each surviving child consumes an extra part ϕ of this time[19]. So the quantity cost of a surviving child is greater than the cost of a non surviving child. The total cost of quantity is equal to $\left[\frac{\sigma}{\xi} + \phi\right] w_t h_t X_t$. It includes the ineffective costs engaged for non surviving children. Consequently it negatively depends on the child survival rate.

The cost of one unit of education is not affected by the variations in the child mortality rate. Indeed, no educational investment is engaged until a child reaches age five. The total cost of education is concave in X_t, one unit of education can benefit more than one child. $\theta w_t \overline{h_t} \Omega\left(X_t\right) \cdot e_t$ denotes the cost of giving e_t units of education to X_t children with $\Omega'(X_t) \geq 0$ and $\Omega''(X_t) \leq 0$[20].

[18] Notice that for all function $\Gamma(\alpha_1, \alpha_2, ..., \alpha_n, ...)$, Γ'_n represents the partial derivative of Γ with regard to α_n.

[19] Note that $\frac{\sigma}{\xi} + \phi < 1$. $\theta > 0$ is a scalar that allows the relative education costs to vary.

[20] If education is a pure public good in the family ($\Omega(X_t) = 1$), providing e_t units of education to one child implies the same cost as providing e_t units to X_t children. If education is a pure private good in the family ($\Omega(X_t) = X_t$), one unit of education benefits only one child. Then the total cost of education equals the unitarian cost of education times the number of surviving children.

The price of the final good is normalized to one. It is produced in quantity Y_t, following a linear technology:

$$Y_t = AH_t \tag{1.4}$$

A is a productivity factor and H_t is the total amount of human capital in the workforce. At the labor market's equilibrium, H_t is:

$$H_t = \left[1 - \left(\frac{\sigma}{\xi} + \phi\right) X_t - \theta e_t \Omega\left(X_t\right)\right] h_t L_t \tag{1.5}$$

Notice that, ex-post, at the equilibrium of the labor market, $\overline{h_t} = h_t$. By assumption, there is no inequality of human capital. The workforce participation of a parent consists in his remaining time after childbearing, and teachers do not participate in the production of the final good. Furthermore, as the labor market is competitive, the wage equals the workers' marginal productivity:

$$w_t = A \tag{1.6}$$

A parent born in $t-1$ determines his optimal demands $\left(C_t^*, X_t^*, h_{t+1}^*\right)$ by maximizing $u_t = U\left(C_t, X_t, h_{t+1}\right)$ with respect to C_t, X_t and h_{t+1}[21] subject to (1.2) and (1.3). This problem can be solved by maximizing the objective function $V_t\left(X_t, h_{t+1}\right)$ with respect to X_t and h_{t+1} :

$$V_t\left(X_t, h_{t+1}\right) \equiv U\left(w_t h_t - \left[\tfrac{\sigma}{\xi} + \phi\right] w_t h_t X_t - \theta w_t \overline{h_t} \Omega\left(X_t\right) e\left(h_{t+1}, h_t, \overline{h_t}\right), X_t, h_{t+1}\right) \tag{1.7}$$

To ensure global concavity of the problem, its Hessian Matrix is assumed to be negative semi-definite. The competitive equilibrium is described by the set C_t^*, X_t^*, e_t^* $h_t^*, \overline{h_t^*}, h_{t+1}^*, H_t^*, Y_t^*, w_t^*$ satisfying equations $(1.2), (1.3), (1.4), (1.5), (1.6)$ and the

[21] Note that, h_{t+1} depends on the family's human capital, the average human capital and the educational choices of parents. As parents know the level of h_t and $\overline{h_t}$ when they determine e_t; choosing e_t is equivalent to choosing h_{t+1}.

following First Order Conditions:

$$U'_X = \left(\frac{\sigma}{\xi} + \phi + \theta\Omega'\left(X_t^*\right) e\left(h_{t+1}^*, h_t^*, h_t^*\right)\right) A h_t^* U'_C \tag{1.8}$$

$$\frac{U'_{h_{t+1}}}{U'_C} = \theta A h_t^* \Omega\left(X_t^*\right) e'_1\left(h_{t+1}^*, h_t^*, h_t^*\right) \tag{1.9}$$

The existence of externalities on human capital accumulation implies that the competitive equilibrium cannot be optimal. The next sections derive the social optimum of the economy and compare it to the competitive equilibrium.

1.2 The Social Optimum

The presence of externalities makes private choices on education inefficient. Parents do not consider the positive effect of their educational investment on the overall efficiency of human capital accumulation. Consequently, they naturally tend to under invest in education. Intuitively, the implementation of a subsidy on education should be sufficient to correct this distortion. Equilibrium would be ensured by the existence of a lump sum transfer. However, doing so implicitly assumes that education is a pure public good within the family and that the objective of the social planner is the same as the objective of the representative agent.

Defining the social planner's objective function is not straightforward. The crucial point lies in his preference for the size of populations. A large set of papers dealing with optimality in endogenous fertility models attribute a Millian objective to the Social Planner[22]. In this case, the social planner tries to maximize the utility of the representative agent $U(C, X, h)$ at the steady state. Doing so implies that he is interested in the well-being of the representative agent without taking into account the size of the population enjoying $U(C, X, h)$. This representation of social preferences is often opposed to the Benthamite social welfare functions. With a

[22] See Groezen *et al.* [2003], Wigniolle & Loupias [2004], Zhang [2003], Zhang & Zhang [2007], etc. This formulation can also be included in the A-Efficiency problems from Golosov *et al* [2007].

Benthamite utility, the Social Planner tries to maximize the total utility distributed in the economy.

In the present paper, I propose a general social welfare function which includes the Millian and Benthamite cases as well as intermediary ones[23]. To do so, a "natalist bias" denoted $f(X)$ is introduced in the Social Planner's preferences. The Social Welfare function, at the steady state, is then[24]:

$$SU = f(X)\, U(C, X, h) \tag{1.10}$$

This formulation is a generalization of the Millian case where $f(X) = 1$. $f(X)$ represents the "social planner's Natalist Bias". Following Nerlove *et al* [1986], when $f(X) = 1 + X$, the maximand of a stationary Benthamite social welfare function reduces to the Welfare social function in (1.10). More generally, for a given X, a higher value of $f(X)$ means that the Social planner exhibits a higher natalist bias. In other words, *ceteris paribus*, he prefers larger generations. $f(X)$ is assumed to be increasing and concave in X[25][26].

Then, the social planner maximizes (1.10) subject to the following resource constraint[27]:

$$C = \left[1 - \left(\frac{\sigma}{\xi} + \phi\right) X - \theta\Omega(X)\, e\right] Ah \tag{1.11}$$

[23]Notice that Rawlsian objectives are not included in this simple formulation.

[24]Notice that, as in Groezen *et al.* [2003], Wigniolle & Loupias [2004], Zhang [2003], Zhang & Zhang [2007], etc., I only focus on the social welfare function at the steady state. The decentralization of the dynamical optimal path would require to define the Social Planner objective as follows:

$$SU = L_0 \sum_{t=0}^{+\infty} \left(\frac{1}{1+\beta}\right)^t \left[\left(\prod_{s=0}^{t-1} X_s\right) u(C_t, X_t, h_{t+1})\right]$$

[25]$f'(X) > 0$ simply means that distributing $\overline{U}$ to one agent is less valuable than distributing $\overline{U}$ to $X > 1$ agents. $f''(X) \leq 0$ ensures the existence of the trade-off between the utility distributed to the representative agent and the size of the generation enjoying it.

[26]Notice that no other externality on fertility is introduced. Doing so would enrich the model of alternative mechanisms but will not change its main results.

[27]To ensure global concavity of the problem, its Hessian matrix is assumed to be negative semi-definite

The optimal steady state is described by the set $\left\{\widehat{C},\widehat{X},\widehat{h}\right\}$ satisfying equation (1.11) and the following First Order Conditions:

$$U'_X = -\frac{f'\left(\widehat{X}\right)}{f\left(\widehat{X}\right)}U\left(\widehat{C},\widehat{X},\widehat{h}\right)+\left(\frac{\sigma}{\xi}+\phi+\theta\Omega'\left(\widehat{X}\right)e\left(\widehat{h},\widehat{h},\widehat{h}\right)\right)A\widehat{h}U'_C \quad (1.12)$$

$$\frac{U'_{h_{t+1}}}{U'_C} = A\left(\widehat{X}\left[\frac{\sigma}{\xi}+\phi\right]+\theta\Omega\left(\widehat{X}\right)\left[e\left(\widehat{h},\widehat{h},\widehat{h}\right)+\widehat{h}\left(\widehat{e}'_1+\widehat{e}'_2+\widehat{e}'_3\right)\right]-1\right) \quad (1.13)$$

Obviously, at the optimal steady state, all the existing externalities are taken into account. In this economy, externalities concern the accumulation of human capital. When parents invest in education, they improve the future human capital of their children, such that, in turn, they improve both the future average level of human capital in the whole economy and their dynasty's level of human capital. However, parents do not take into account their positive impact on the future efficiency of the accumulation process. It implies that they tend to underinvest in education and to have too many children.

Furthermore, the preferences of parents can differ from the preferences of the social planner. Parents are not concerned with pro-natalism or equity between generations. Consequently, they could have too few children. The competitive equilibrium can then be characterized by over or under fertility. The implementation of an economic policy is required.

1.3 The Optimal Tax-Transfer Policy

In order to decentralize the social optimum, the government has to implement a public policy which makes the competitive steady state[28] converge to the optimal one. An optimal policy makes the set $\{C^*,X^*,h^*\}$ identical to the set $\left\{\widehat{C},\widehat{X},\widehat{h}\right\}$. The following subsections discuss the optimal tax-transfer policies in the general case

[28] At the competitive steady state, $h^*_{t+1}=h^*_t=\overline{h^*_t}$.

($\Omega(X) \neq 1$) and in the specific case where education is a pure public good inside the family ($\Omega(X) = 1$).

To summarize, there exist externalities on human capital accumulation and a difference between the Social Planner's preferences and the representative agent's ones. So, the first order conditions for quality and quantity are distorted and two distortive taxes or subsidies are required. One major result of this exercise will be that these two distortive taxes are required even in the Millian case (no difference between objectives of the Social Planner and of the representative parent) where there exist only one externality.

As previously mentioned, the choice of instruments is restricted to linear taxes. There only exist three "goods": the consumption good, the education and the quantity of children. Because taxing consumption would not correct the distortions on the relative cost of quantity and quality, taxing births is the only way to decentralize the first best social optimum.

Obviously, such a family policy will not be required in the Millian case when education is a pure public good inside the family ($\Omega(X) = 1$). The following subsections demonstrate these results.

1.3.1 Optimal Tax-Transfer Policy in the general case

Proposition 1 *Whatever the intensity of the social planner's natalist bias, a policy of education subsidies is optimal when it is combined with a family policy that can be either a tax or a subsidy on births. The government budget constraint has to be balanced by the implementation of a lump sum tax on each family.*

Proof. The economic policy described in Proposition 1 leads to the following

competitive steady state:

$$U'_X = \left(\frac{\sigma-\Lambda}{\xi}+\phi+\Omega'\left(X^*\right)\theta\left(1-\kappa\right)e\left(h^*,h^*,h^*\right)\right)Ah^*U'_C \quad (1.14)$$

$$\frac{U'_h}{U'_C} = \theta Ah^*\Omega\left(X^*\right)\left(1-\kappa\right)e'_1\left(h^*,h^*,h^*\right) \quad (1.15)$$

$$C^* = \left[1-\left(\frac{\sigma-\Lambda}{\xi}+\phi\right)X^*+\theta\left(1-\kappa\right)e\left(h^*,h^*,h^*\right)\Omega\left(X^*\right)\right]Ah^*-t \quad (1.16)$$

$$t = \kappa\theta e\left(h^*,h^*,h^*\right)\Omega\left(X^*\right)Ah^*+\frac{\Lambda}{\xi}X^*Ah^* \quad (1.17)$$

$\Lambda > 0$ (resp $\Lambda < 0$) represents a subsidy (resp a tax) on each child birth. $\kappa > 0$ (resp $\kappa < 0$) denotes a subsidy (resp a tax) on educational investment. When parents invest in one unit of education, they only pay a part $1-\kappa$ of this investment. t is the lump sum transfer making the government budget constraint balanced. Equation (1.17) represents the government budget constraint; equations (1.14) and (1.15) are just the expression of equations (1.8) and (1.9) when the economic policy is implemented.

Observing systems $\{1.11, 1.12, 1.13\}$ and $\{1.14, 1.15, 1.16, 1.17\}$, any policy making the sub-systems $\{1.14, 1.15\}$ and $\{1.12, 1.13\}$ identical, decentralizes the social optimum. Indeed, (1.16) and (1.17) imply that (1.11) is satisfied. It follows that[29]:

$$\widehat{\kappa} = \frac{1-\widehat{X}\left[\frac{\sigma}{\xi}+\phi\right]-\theta\Omega\left(\widehat{X}\right)\left[\widehat{e}+h\left(\widehat{e}'_2+\widehat{e}'_3\right)\right]}{\theta\Omega\left(\widehat{X}\right)\widehat{h}\widehat{e}'_1} \quad (1.18)$$

$$\frac{\widehat{\Lambda}}{\xi} = \frac{f'\left(\widehat{X}\right)}{f\left(\widehat{X}\right)}\frac{\widehat{U}}{A\widehat{h}\widehat{U}'_C}-\frac{\Omega'\left(\widehat{X}\right)\widehat{e}}{\Omega\left(\widehat{X}\right)\widehat{h}\widehat{e}'_1}\left(1-\widehat{X}\left[\frac{\sigma}{\xi}+\phi\right]-\theta\Omega\left(\widehat{X}\right)\left[\widehat{e}+\widehat{h}\left(\widehat{e}'_2+\widehat{e}'_3\right)\right]\right) \quad (1.19)$$

$$\widehat{t} = \varepsilon_{\widehat{X}}^{f(\widehat{X})}\frac{\widehat{U}}{\widehat{U}'_C}+A\widehat{e}^{\frac{1-\varepsilon_{\widehat{X}}^{\Omega(\widehat{X})}}{\widehat{e}'_1}}\left(1-\widehat{X}\left[\frac{\sigma}{\xi}+\phi\right]-\theta\Omega\left(\widehat{X}\right)\left[\widehat{e}+\widehat{h}\left(\widehat{e}'_2+\widehat{e}'_3\right)\right]\right) \quad (1.20)$$

By (1.11), $\widehat{\kappa}$ can be expressed as:

$$\widehat{\kappa} = \frac{\frac{\widehat{C}}{A\widehat{h}}-\theta\Omega\left(\widehat{X}\right)h\left(\widehat{e}'_2+\widehat{e}'_3\right)}{\theta\Omega\left(\widehat{X}\right)\widehat{h}\widehat{e}'_1}$$

[29] Notice that $\widehat{U} \equiv U\left(\widehat{C},\widehat{X},\widehat{h}\right)$ and $\widehat{e} = e\left(\widehat{h},\widehat{h},\widehat{h}\right)$.

$\widehat{e}'_2 + \widehat{e}'_3 < 0$ implies that $\widehat{\kappa}$ is always positive. The optimal education policy is always a subsidy. $f'(\widehat{X})$ and $\Omega'\left(\widehat{X}\right)$ being different from zero, $\widehat{\Lambda}$ and $\widehat{t}$ are also different from zero: a tax-transfer policy on births and a lump sum tax are effectively required to reach the optimal steady state. ■

An education subsidy has to be implemented because the human capital accumulation process is affected by externalities. Parents do not internalize all the returns of their investment in education. Then their laissez faire investment in children's human capital is slower than the optimal one.

The optimal fiscal policy on births has two determinants. The first one is the social planner's natalist bias. If the social planner exhibits a strong preference for large populations, the laissez faire fertility rate tend to be smaller than at the optimum. The second determinant of the optimal policy on births is the optimal education policy itself. The non linearity of the parental budget constraint implies that a reduction in the education costs decreases the total net cost of a surviving child. Then parents tend to have more children at the laissez faire equilibrium than at the optimum. One main issue of that paper is to determine the conditions where births have to be taxed[30].

Proposition 2 *For low intensities of the social planner's natalist bias such that* $0 < \varepsilon_{\widehat{X}}^{f(\widehat{X})} < \widetilde{\varepsilon}$, *to tax births is an optimal family policy.*

Proof. After some calculus on (1.19), the following condition can be obtained:

$$\frac{\widehat{\Lambda}}{\xi} < 0 \Leftrightarrow \varepsilon_X^{f(X)} < \frac{\varepsilon_C^{U(C,X,h)} \cdot \varepsilon_X^{\Omega(X)}}{\varepsilon_{h_{t+1}}^e} \left(1 - \frac{\theta\Omega(X)Ahe}{C}\left[\varepsilon_{h_t}^e + \varepsilon_{\overline{h}_t}^e\right]\right) \equiv \widetilde{\varepsilon} \qquad (1.21)$$

$\varepsilon_{h_t}^e + \varepsilon_{\overline{h}_t}^e < 0$ implies that $\widetilde{\varepsilon} > 0$. ■

[30] Let $\varepsilon_m^{p(m)}$ denote the elasticity of $p(m)$ with regard to m. So $\varepsilon_m^{p(m)} \equiv \frac{\frac{\partial p(m)}{\partial m} \cdot m}{p(m)}$ $\forall m$ and $\forall p(\cdot)$ being twice differentiable.

The value of $\widetilde{\varepsilon}$ is determined by the model's key variables. When the elasticity of utility to consumption ($\varepsilon_C^{U(C,X,h)}$) is high, parents consume a large part of their income and have few children. Therefore, all other things being equal, the competitive fertility rate is low and the tax level has not to be very high and could even become a subsidy.

When the private returns of investment in human capital are high (low values of $\varepsilon^e_{h_{t+1}}$) relative to its social returns ($\varepsilon^e_{h_{t+1}} - \left[\varepsilon^e_{h_t} + \varepsilon^e_{\overline{h_t}}\right]$), the tax will be low. Indeed, this implies that the distortions on educational choices are low, so the educational subsidy is low. Because the tax on births corrects the distortion provoked by the subsidy on education, its level will be low too.

Corollary 3 *When the Social Welfare function is Millian ($\varepsilon_X^{f(X)} = 0$), the optimal tax transfer policy for fertility is necessarily a tax on births.*

Proof. If $\varepsilon_X^{f(X)} = 0$, (1.21) is always satisfied. ■

Indeed, when the social planner has the same preferences as parents, initially, at the competitive steady state, fertility behaviors are optimal. However, when the social planner implements subsidies on educational investment, the cost of quantity also decreases. Then over fertility appears and a tax on births has to be implemented.

This result is crucial for models of trade-off between quality and quantity. It implies that implementing generous education policies could require restrictive family policies when education is not a pure public good into the family. The following sub-section explores the preceding optimal fiscal scheme in the specific case where education is a pure public good inside the family.

1.3.2 Optimal Policy when education is a pure public good in the family

In this case, the cost of providing e_t units of education to one child is the same as the cost of providing e_t units of education to an infinite number of children. It implies that the preceding results are modified.

Proposition 4 *When education is a pure public good in the family, taxing births is never necessary to decentralize the optimal steady state. Furthermore, if the social planner does not exhibit a natalist bias, no tax or transfer on fertility is required to reach the optimal steady state.*

Proof. If $\Omega'(X) = 0$, the fiscal scheme decentralizing the optimal steady state is the expression of system $\{1.18, 1.19, 1.20\}$ with $\Omega(X) = 1$ and $\Omega'(X) = 0$:

$$\widehat{\kappa} = \frac{1 - \widehat{X}\left[\frac{\sigma}{\xi} + \phi\right] - \theta\left[\widehat{e} + h\left(\widehat{e}'_2 + \widehat{e}'_3\right)\right]}{\theta \widehat{h} \widehat{e}'_1} \tag{1.22}$$

$$\frac{\widehat{\Lambda}}{\xi} = \frac{f'(\widehat{X})}{f(\widehat{X})} \frac{U}{A\widehat{h}U'_C} \tag{1.23}$$

$$\widehat{t} = \varepsilon_{\widehat{X}}^{f(\widehat{X})} \frac{U}{U'_C} + \frac{A\widehat{e}}{\widehat{e}'_1}\left(1 - \widehat{X}\left[\frac{\sigma}{\xi} + \phi\right] - \theta\Omega\left(\widehat{X}\right)\left[\widehat{e} + \widehat{h}\left(\widehat{e}'_2 + \widehat{e}'_3\right)\right]\right) \tag{1.24}$$

By the proof of Proposition 3, $\widehat{\kappa} > 0$. Education has to be subsidized. It is straightforward that $\widehat{\Lambda} \geq 0$. When $f'(X) = 0$, it follows from (1.23) that $\widehat{\Lambda} = 0$, $\widehat{\kappa} > 0$ and $\widehat{t} > 0$. ■

The fundamental results of the model have not really changed. Equation (1.19) is still satisfied. However, education policies no longer distort fertility behaviors. Indeed, as education is a pure public good into the family, total costs of education are not influenced by the number of children enjoying the educational investment. So only the distance between the social planner's preferences and the household's preferences can make fertility behaviors non optimal. Without this bias, competitive fertility choices are optimal and no tax or transfer on fertility is required.

As a first major result, in a standard model of trade-off between quality and quantity, a tax-transfer policy on fertility is always required to reach the optimal steady state if education is not a pure public good. In other words, without the implementation of a tax or a subsidy on births, an education policy is not completely effective.

In the following Section, the model is extended to include private health expenditure. Despite the modification of the nature of the trade-off between quality and quantity, the need to tax births will not be canceled by the introduction of health expenditure.

2 Optimal Tax-Transfer policy with health expenditure

The child survival probability is now endogenous. Parents can engage in health expenditure in order to reduce their children's mortality rate. In line with Chakraborty [2004], the child survival probability ξ_t is now:

$$\xi_t \equiv \xi\left(s_t, \overline{s_t}\right) \tag{1.25}$$

Parental expenditure on health has a strictly positive and concave influence on the children's survival probability, so $\xi_1' \equiv \frac{\delta\xi(s_t,\overline{s_t})}{\delta s_t} > 0$ and $\xi_{11}'' \equiv \frac{\delta^2\xi(s_t,\overline{s_t})}{\delta {s_t}^2} < 0$. This expenditure represents the health care provided by parents to children. Parental health care covers a large set of expenditure such as hygiene, sanitation improvements and efficient nutrition. $\overline{s_t}$ denotes the average health expenditure in the economy. In line with Dasgupta [1993], $\xi_2' \equiv \frac{\delta\xi(s_t,\overline{s_t})}{\delta \overline{s_t}} > 0$ and $\xi_{22}'' \equiv \frac{\delta^2\xi(s_t,\overline{s_t})}{\delta \overline{s_t}^2} < 0$.

The introduction of an externality on health expenditure implies that the parental choices on s_t will not be efficient at the competitive equilibrium. Intuitively, one can expect that the competitive level of health expenditure will be inferior to

its optimal level. However, the existence of educational inefficiency could alter this result because, as previously shown, it decreases the total cost of quantity.

2.1 The Competitive Equilibrium

Parents now have to determine health expenditure for their children. In other words, they choose X_t and s_t. The addition of an externality on health spending implies that private health investment will not be optimal. Then the government introduces a subsidy r_t on health expenditure in complement to the previous fiscal system. The government budget constraint is now[31]:

$$t_t = \kappa_t \theta e\left(h_{t+1}, h_t, h_t\right) X_t w_t h_t + \frac{\Lambda_t w_t h_t}{\xi\left(s_t, \overline{s_t}\right)} X_t + r_t s_t \tag{1.26}$$

When the fiscal scheme is implemented, the familial budget constraint is:

$$C_t + \left(1 - r_t\right) s_t + \left[\frac{\sigma - \Lambda_t}{\xi\left(s_t, \overline{s_t}\right)} + \phi\right] w_t h_t X_t + \left(1 - \kappa_t\right) \theta w_t \overline{h_t} X_t \cdot e_t = w_t h_t \tag{1.27}$$

Now the final good can either be consumed or invested in health. Parents have to maximize the objective function $U\left(C_t, X_t, h_{t+1}\right)$ with regard to C_t, X_t and h_{t+1} and with respect to (1.27). As health expenditure does not enter the objective function, parents determine their optimal health expenditure by minimizing $\left(1 - r_t\right) s_t + \frac{\sigma - \Lambda_t}{\xi\left(s_t, \overline{s_t}\right)} w_t h_t X_t$. It follows that, at the competitive steady state:

$$1 - r = \frac{\left[\sigma - \Lambda\right] \xi_1^{*\prime}}{\left[\xi\left(s^*, s^*\right)\right]^2} X^* w h^* \tag{1.28}$$

Parents equalize the marginal return and the marginal cost of health expenditure $(1-r)$. The marginal benefit of health expenditure $\left(\frac{[\sigma-\Lambda]\xi_1^{*\prime}}{[\xi(s^*,s^*)]^2} X^* w h^*\right)$ consists in the reduction of the total cost of quantity[32]. In other words, equation (1.28) determines the optimal parental spending on health to have X_t surviving children.

[31] To simplify the results, $\Omega'(X) = 1$. Education is a pure private good.

[32] As mentionned in the Benchmark model, a higher child survival rate decreases the cost of quantity.

The competitive steady state is now described by the set $\left\{C^*, X^*, s^*, e^*, h^*, \overline{h^*}, H^*, Y^*, w^*\right\}$ satisfying equations $(1.5), (1.6), (1.27), (1.28)$ and the following first order conditions with regard to X and h:

$$\frac{U'_X}{U'_C} = \frac{(\sigma - \Lambda + [\phi + (1-\kappa)\theta e(h^*, h^*, h^*)]\xi(s^*, s^*))}{\xi(s^*, s^*)} wh^* \quad (1.29)$$

$$\frac{U'_{h_{t+1}}}{U'_C} = (1-\kappa) X^* \theta w h^* e'_1(h^*, h^*, h^*) \quad (1.30)$$

Equations (1.28) and (1.29) show that the taxation of births increases the marginal cost of quantity and increases the marginal benefits of health expenditure.

2.2 The Social Optimum

For simplicity, $f(X) = 1$ is assumed. The social planner maximizes a Millian Social Welfare function $SU = U(C, X, h)$. He holds a new maximization instrument s and he faces a new resource constraint:

$$C + s = \left[1 - \left(\frac{\sigma}{\xi(s, \overline{s})} + \phi + \theta e\right) X\right] Ah \quad (1.31)$$

At the steady state $s = \overline{s}$. The social planner determines the optimal health expenditure by minimizing $\frac{\sigma}{\xi(s,s)} XAh + s$ with regard to s. Doing so, he equalizes the marginal social cost of health spending (equal to one) to its marginal social return. Obviously, the marginal social benefit of health spending is higher than the marginal private benefit (calculated in equation (1.28)). Formally, the optimal decision rule for s is:

$$1 = \frac{\sigma\left[\widetilde{\xi}'_1 + \widetilde{\xi}'_2\right]}{\left[\xi(\widehat{s}, \widehat{s})\right]^2} \widehat{X} A \widehat{h} \quad (1.32)$$

The optimal equilibrium now results from the maximization of the following objective function with regard to X and h :

$$SU = U\left(\left[1 - \left(\frac{\sigma}{\xi(\widehat{s}, \widehat{s})} + \phi + \theta e\right) X\right] Ah - \widehat{s}, X, h\right)$$

Then the Social Optimum is described by the set $\left\{\widehat{C},\widehat{X},\widehat{h},\widehat{s}\right\}$ satisfying the equation (1.31), (1.32) and the following conditions:

$$\frac{U'_X}{U'_C} = \frac{\left(\sigma+\left[\phi+\theta e\left(\widehat{h},\widehat{h},\widehat{h}\right)\right]\xi\left(\widehat{s},\widehat{s}\right)\right)}{\xi\left(\widehat{s},\widehat{s}\right)}A\widehat{h} \tag{1.33}$$

$$\frac{U'_{h_{t+1}}}{U'_C} = A\left(\widehat{X}\left[\frac{\sigma}{\xi\left(\widehat{s},\widehat{s}\right)}+\phi+\theta e\left(\widehat{h},\widehat{h},\widehat{h}\right)+\theta\widehat{h}\left(\widehat{e}'_1+\widehat{e}'_2+\widehat{e}'_3\right)\right]-1\right) \tag{1.34}$$

2.3 The Optimal Tax-Transfer Policy

An optimal policy has to make identical systems $\{(1.32),(1.33),(1.34)\}$ and $\{(1.28),(1.29),(1.30)\}$. In consequence, the optimal fiscal scheme is:

$$\widehat{\kappa} = \frac{1-\widehat{X}\left[\frac{\sigma}{\xi(\widehat{s},\widehat{s})}+\phi+\theta\widehat{e}+\theta\widehat{h}\left[\widehat{e}'_2+\widehat{e}'_3\right]\right]}{\theta\widehat{X}\widehat{h}\widehat{e}'_1} \tag{1.35}$$

$$\frac{\widehat{\Lambda}}{\xi} = \frac{\widehat{e}}{\widehat{X}\widehat{h}\widehat{e}'_1}\left(\widehat{X}\left[\frac{\sigma}{\xi\left(\widehat{s},\widehat{s}\right)}+\phi+\theta\widehat{e}\left(1+\varepsilon^e_h+\varepsilon^e_{\overline{h}}\right)\right]-1\right) \tag{1.36}$$

$$\widehat{r} = 1-\frac{\varepsilon^{\xi(s,\overline{s})}_s}{\varepsilon^{\xi(s,\overline{s})}_s+\varepsilon^{\xi(s,\overline{s})}_{\overline{s}}}\left[1+\frac{\widehat{e}\left(1-\widehat{X}\left[\frac{\sigma}{\xi(\widehat{s},\widehat{s})}+\phi+\theta\widehat{e}\left(1+\varepsilon^e_h+\varepsilon^e_{\overline{h}}\right)\right]\right)}{\widehat{X}\widehat{h}\widehat{e}'_1}\right] \tag{1.37}$$

$$\widehat{t} = \varepsilon^{\xi(s,\overline{s})}_{\overline{s}}\frac{\sigma A\widehat{h}}{\xi\left(\widehat{s},\widehat{s}\right)}\widehat{X}-\frac{Ah\varepsilon^{\xi(s,\overline{s})}_s\left(1-\widehat{X}\left[\frac{\sigma}{\xi(\widehat{s},\widehat{s})}+\phi+\theta\widehat{e}\left(1+\varepsilon^e_h+\varepsilon^e_{\overline{h}}\right)\right]\right)}{\varepsilon^e_{h+1}} \tag{1.38}$$

Optimal values of $\widehat{\kappa}$ and $\widehat{\Lambda}$ are the same as in the previous Section (given that the optimal values of $\widehat{C},\widehat{X}$ and $\widehat{h}$ have changed). It implies that Proposition 1 still applies. In other words, whatever the intensity of the social planner's natalist bias, a policy of education and health subsidies is optimal when it is combined with a tax-transfer policy on births. Here, because the social planner exhibits no natalist bias, the optimal family policy always consists in a tax on births. The government budget constraint still has to be balanced by the implementation of a lump sum tax on each family.

Proposition 5 *When the externality on health expenditure is strong such that* $\varepsilon^{\xi(s,\overline{s})}_{\overline{s}} > \overline{\varepsilon}$, *the optimal health policy consists in a subsidy.*

Proof. It is straightforward to show that parental health expenditure is not optimal at the competitive steady state.

At the competitive steady state (without taxation), (1.28) and (1.29) imply:

$$s^* = \varepsilon_s^{\xi(s,\overline{s})} \sigma AhN$$

At the optimal steady state, (1.32) and (1.33) imply $\widehat{s} = \left[\varepsilon_s^{\xi(s,\overline{s})} + \varepsilon_{\overline{s}}^{\xi(s,\overline{s})}\right] \sigma AhN$. It follows that $s^* < \widehat{s}$. However $s^* < \widehat{s}$ does not ensure that health expenditure should always be subsidized. (1.32) and (1.33) indicates that the optimal value of health subsidies is:

$$\widehat{r} = 1 - \frac{\varepsilon_s^{\xi(\widehat{s},\widehat{s})}}{\varepsilon_s^{\xi(\widehat{s},\widehat{s})} + \varepsilon_{\overline{s}}^{\xi(\widehat{s},\widehat{s})}} \left(1 - \frac{\widehat{\Lambda}}{\sigma}\right)$$

Then, $\widehat{r}$ is positive if the following condition holds:

$$\varepsilon_{\overline{s}}^{\xi(\widehat{s},\widehat{s})} > -\varepsilon_s^{\xi(\widehat{s},\widehat{s})} \frac{\widehat{\Lambda}}{\sigma} \equiv \overline{\varepsilon}$$

■

When the externality on $\overline{s}$ is strong such that $\varepsilon_{\overline{s}}^{\xi(\widehat{s},\widehat{s})} > \overline{\varepsilon}$, health expenditure has to be subsidized because parents tend to largely underinvest in health. Conversely, externalities on education are strong such that $\overline{\varepsilon} > \varepsilon_{\overline{s}}^{\xi(s,\overline{s})}$, health expenditure has to be taxed[33]. This result comes from the non linearity of the costs structure. Indeed, the existence of an externality on health expenditure implies that parents do not internalize all the returns of their investment in children's health. The comparison of (1.28) with $\Lambda = r = 0$ and (1.32) indicates that health expenditure at the competitive steady state is lower than at the optimal steady state. However, when education is subsidized, a tax on births has to be implemented. Doing so, the cost of quantity is increased relative to the cost of health, so parents tend to increase their health expenditure. The tax on births plays the role of an indirect subsidy on

[33] $\overline{\varepsilon}$ positively depends on $\widehat{\Lambda}$ which, in turn, positively depends on $\varepsilon_{h_{t+1}}^e$.

health. Finally, the sign of $\widehat{r}$ is determined by the difference between the intensity of the externality on health expenditure and the size of the indirect subsidy. If the externality on health is relatively strong ($\varepsilon_{\overline{s}}^{\xi(\widehat{s},\widehat{s})} > \overline{\varepsilon}$), the indirect subsidy will not be sufficient to reach $\widehat{s}$, so $\widehat{r}$ will be positive. Conversely, if the externality on health is relatively weak ($\varepsilon_{\overline{s}}^{\xi(\widehat{s},\widehat{s})} < \overline{\varepsilon}$), the indirect subsidy exceeds the health subsidy that is really needed. So $\widehat{r}$ will be negative: health expenditure will be taxed.

To summarize, the present paper provides two results. First, whenever it is optimal to subsidize education *and* health, it is optimal to implement a tax - transfer policy on births even when fertility is not a source of externalities. This policy always consists in a tax on births when the social planner has no natalist bias. Second, when the social returns on health expenditure are not sufficiently high, the optimal family planning program of the economy consists in the promotion of education financed by the taxation of health and births and a lump sum tax. Conversely, when the social returns on health expenditures are high, the optimal family planning program consists in the promotion of education and health financed by the taxation of births and a lump sum tax[34]. This optimal policy has, in fact, two main objectives. The first one is to modify the parental trade-off between quality and quantity. More precisely, the government has to incite parents to transfer a part of their spending on fertility toward education investment. The second objective is to modify the parental trade-off between fertility and health. In order to reach the same number of surviving children, parents are incited to make less children in better health.

[34]Following Dasgupta [1993], the social returns on health expenditure are high. Then, the promotion of education and health financed by the taxation of births is a more realistic conclusion.

3 Some Empirical Issues At Stake

In this section, I discuss the main theoretical conclusion of the model in the light of some empirical evidence from countries facing over population problems. Obviously, the strong simplicity of the model does not allow to reproduce the very complex demographic puzzles of these countries. It imposes to limit the discussion on general statements.

Countries which face over-population problems implement active policies to slacken their population growth rate. Two examples are particularly illuminating: China and Sub-Saharan Africa. Although these two regions both face overpopulation problems, their family policies have been noticeably different. In the light of the theoretical fiscal scheme proposed in this paper, this Section provides a brief reflection on the improvements that could be made to the current policies implemented in these countries.

A recent report of the World Bank [2007] underlines that 31 of the 35 countries with the highest fertility rates come from Sub-Saharan Africa. For the majority of them, fertility rates have not changed over the last decades and are all greater than six children per woman. However, the vast majority of these countries have implemented family planning programs in collaboration with international organizations such as the World Bank.

The World Bank's report [2007] emphasizes that the main factor in the high fertility rates is the persistent high level of the desired number of children. In other words, the too high fertility rates in Sub-Saharan Africa do not come from the lack of family planning programs available. It argues that efforts have to be made to reduce the desired fertility. To do so, it recommends improving education and health programs at the local level. However, education indicators have all been increasing

since the sixties. More recently, the net primary school enrolment rate increased from 50 to 70 percent between 1990 and 2006. In the same period, the youth and adult literacy rates increased[35]. This noticeable improvement in education rates has not been sufficient to reduce fertility rates.

The present paper does not recommend increasing the amount spent on the family planning programs. It proposes complementing family planning programs with taxes on births helping to finance education and health. Without taxing births, these programs reduce the net cost of the children's quantity, implying the persistence of a high desired number of children.

Obviously, the Sub-Saharan African population puzzle cannot be reduced to a simple model of fertility. More complex problems of political instability, starvation and HIV pandemy that are well beyond the scope of this paper, have a direct and significant effect on fertility and education behavior. The possibility of implementing taxes on births in a population that is largely engaged in an informal economy is particularly questionable. However, the increase of quantity costs has to be contemplated as an instrument of future family planning programs.

China also implements a family policy to reduce its population growth rate. However, its strategy differs from the strategy of family planning programs in Sub-Saharan Africa. Since 1980, China has implemented a One-Child policy which strongly constrains families' fertility. It consists in a system which provides generous subsidies for the first birth and imposes very high taxes on the subsequent births. If parents decide to have a second child without being allowed to do so, they lose a large part of their retirement pension, their child care allowance and other social advantages. Furthermore, some physical sanctions have been implemented in

[35]In Sub-Saharan Africa, the youth literacy rate was 64% in 1990 and 73% in 2006. The adult literacy rate was 54% in 1990 and 61% in 2006. See Appendix 1 for a more complete description.

rural areas. This fiscal scheme is relatively different from the one proposed in this paper. The Chinese policy does not tax all the births at the same rate. The first birth is subsidized whereas the subsequent births are heavily taxed.

The high level of the tax on subsequent births is a very efficient incentive to have only one child. Then the large majority of families are subsidized to reach the target of one child per family. It implies that the Chinese One-Child Policy is a very costly family policy. It cannot finance education and health policies. So, nothing ensures that the relative costs of education and health reach their optimal value. Indeed, a large literature stresses the insufficiency of public expenditure on health and education in Chinese rural areas where the large majority of the population is concentrated (for example, see Kanbur & Zhang [2003] and Fan & Zhang [2000]).

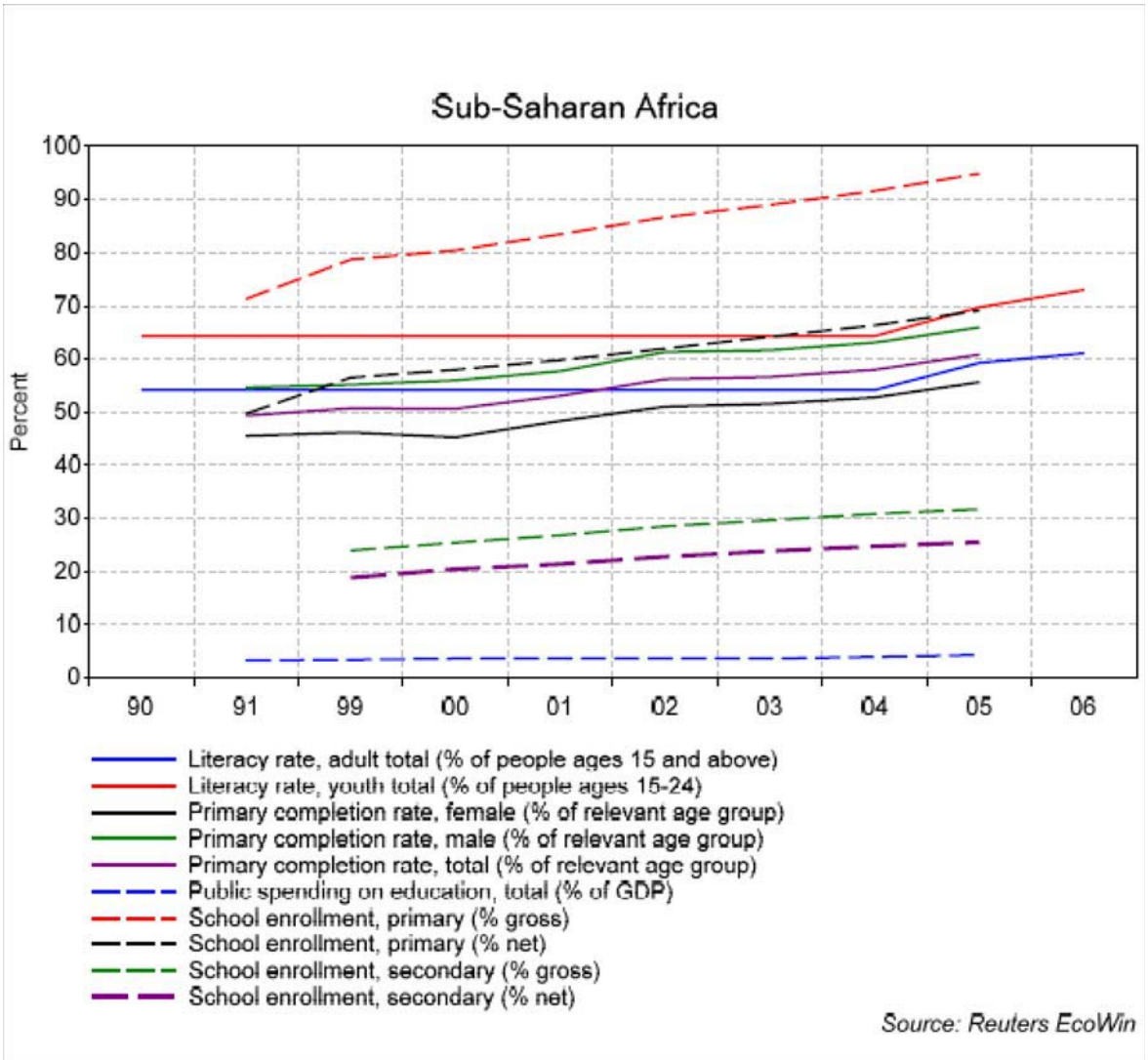
The results of this paper indicate that some marginal changes in the One-Child policy could improve the overall efficiency of the Chinese family planning policy. It proposes taxing all births such that the family policy does not imply effective costs. The amount saved by the Chinese government could be invested in more ambitious education and health policies reducing the large inequalities existing between urban and rural areas. *Theoretically*, this system would not increase the overall cost of the Chinese family planning program and would lead to the same fertility rates. It would, however, increase health and education investment. Furthermore, the Chinese family policy is coercive while the economic policy proposed in this paper is non coercive. Then, if the two policies are equally efficient, the non coercive policy is always welfare improving.

4 Conclusion

The present paper analyses optimal family policies in the standard model of trade-off between quality and quantity. Given the non linearity of the parental budget constraint, to subsidize education and health will be optimal if a tax (or a subsidy) on births is also implemented. Indeed, a subsidy on education reduces both the cost of educational investment and the total cost of fertility. This result applies for a large set of social welfare functions like the Millian and the Benthamite ones. Obviously, the model concludes that taxing births without financing education and health is not optimal either.

Finally, the fiscal scheme proposed in this model is quite simple: education and health expenditure are promoted by the taxation of births and lump sum transfers. The implementation of this scheme could improve the overall efficiency of the current family policies implemented in China and Sub-Saharan Africa. The main objective of the present investigation was to explore the family policy recommendations of the standard endogenous fertility model. As a natural extension of this work, future research should integrate countries' specificities to make quantitative propositions of economic policy and to propose a more precise discussion of empirical evidences.

Appendix



Education in Sub-Saharan AfricaSince 1990

Chapter 2

A Role for Cultural Transmission in Fertility Transitions

Introduction

The consideration of cultural variables in economic analysis has recently experienced a strong renewal coming from recent availability of rich datasets. These datasets make the concept of culture quantifiable and causality between culture and economic variables testable (see Guiso *et al* [2006]). Among its multiple implications, this evolution sheds a new light on the old debate between the "Beckerian Model" of fertility and the "Synthesis Model" of fertility. The first one focuses on the economic determinants of fertility. Becker *et al.* [1973,1976,1988] propose a framework where parents value both the quantity of offsprings and their quality (human capital, wealth, etc.). By maximizing their expected utility subject to a non-linear costs structure, parents face a trade-off between quality and quantity. This fundamental contribution has been followed by major improvements of Galor *et al.* [1996, 1999], De la Croix & Doepke [2003] etc. The second approach, by Easterlin [1978] and Easterlin *et al* [1980], proposes the "Synthesis model" of fertility[1]. In this model, agents are utility maximizers *à la* Becker but culture and social norms are included as determinants of parental utility. Preferences determine individual demands for commodities and children while social norms determine preferences. However, this second approach failed in making endogenous the long run evolution of culture and social norms. As a result, it does not provide a better explanation to the long run evolution of fertility than the Beckerian approach.

In this paper, I argue that interactions between economic and cultural determinants of fertility are at the heart of the long run decrease in fertility. As in the Synthesis Model, culture influences rational fertility behaviors. However, the evolution of economic conditions endogenously shapes the long run dynamics of culture.

[1]Birdsall [1988] provides an enlightening presentation of the Easterlin's contributions.

More precisely, I assume the existence of two alternative cultures in the population. Agents of each cultural group are rational utility maximizers à la Becker. Their preferences are determined by the group they belong to. Belonging to a cultural group consists in adopting the fertility norm of this group and its mode of production. Notice that, I do not explore the determination of the specific norms within each culture but I explore the reasons why such norms can persist over time (or disappear) and their impact on demographic dynamics. In other words, the evolution of culture is endogenous at the scale of the society.

The first culture is called the "Traditional" culture. "Traditionalists" follow an explicit high norm of fertility[2] and adopt a rural mode of production. The second culture is called the "Modern" culture. "Modernists" do not follow any norm of fertility and adopt an industrial mode of production. Historically, this segmentation of the population can be illustrated by religious differences at least in Early Western Europe. This will be discussed in the following section.

The cultural structure of the population results from an endogenous cultural evolution mechanism. This mechanism is based on the theory of endogenous preferences formation and especially follows Bisin and Verdier [2001]. Preferences are acquired through a socialization process. During the first stage of this process, parents try to transmit their culture to their children because they prefer their children to resemble them[3]. If this familial socialization fails, children enter a second stage where they adopt the culture of a role model they are randomly matched with. Because parents rationally choose their socialization effort, the cultural heterogeneity

[2]In effect, traditionalism can also correspond to cultures and groups characterized by low fertility norms. For example, hunters and gatherers societies do not exhibit high fertility norms despite their evident traditionalism.

[3]Bisin and Verdier [2001] argue that parents prefer to have children adopting the same preferences as their own by using the paternalistic altruism theory. Bergstrom & Stark [1993] give some anthropological fundation to explain the imperfect empathy from parents to children.

characterizing the society crucially depends on economic conditions like the costs of raising children, parental incomes and differential productivity between the modes of production.

In this framework, a productivity shock in favor of the industrial mode of production has an "evolutionary effect" in favor of Traditionalists and a "cultural effect" in favor of Modernists. Indeed, this shock implies an increase in the wealth gap between Modernists and Traditionalists. The cultural deviation[4] becomes more acceptable for Traditionalists because their children would enjoy higher incomes when they adopt the modern culture. Consequently, Traditionalist parents reduce their socialization effort. They also increase their fertility because the total expected utility per child is higher. The reverse is true for Modernists: an increase in their relative income make their children's cultural deviation more costly. Then they tend to increase their socialization effort. Furthermore, as children are time consuming, they reduce their fertility. So, as Traditionalists increase their fertility while Modernists decrease their own, the proportion of Traditionalists in the whole population tends to increase: this is called the "evolutionary effect". However, as Modernists rise their socialization efforts while Traditionalists decrease their own, the proportion of Modernists also tends to increase: this is called the "cultural effect".

Interactions between evolutionary and cultural effects imply three major results. First, an asymmetric technological progress in favor of Modernists provokes a fertility transition only when it is combined with a cultural transition making the Modernist culture majoritarian. Second, if Traditionalists are strongly attached to their culture, they will be less sensible to the increase in the wage gap between their mode of production and the Modernists' one. As a consequence, facing the asymmetric technological progress, they will maintain relatively high socialization

[4] A cultural deviation occurs when a child adopts a different culture from the parental one.

efforts[5]: the cultural effect is weak relative to the evolutionary effect. Then, cultural and demographic transitions will appear later and be achieved more rapidly. Third, in an environment where the Modern mode of production is initially weakly productive and does not experience sufficiently strong improvements, the Modernist culture can disappear in the long run. Conversely, if there exists a strongly biased technological progress in favor of the Modern mode of production, the Traditionalist culture disappears. Notice that this biased technological progress needs not be permanent. It only has to maintain a sufficient wage gap between the two modes of production during a limited period of time. Indeed, the disappearance of a culture is an irreversible event.

The rest of the paper is organized as follows. Section 2 presents the existing explanations to the long run decrease in fertility and the contribution of the present paper to this literature. It also discusses the main evidence in favor of the model's assumptions. Section 3 presents the model itself, its microeconomic properties and its long run dynamics. Section 4 proposes some numerical examples. Section 5 concludes.

1 Related literature and Stylized Facts

1.1 Related literature

The existing economic literature provides consistent explanations for the appearance and the pace of the fertility transition. Fertility transition in early developed economies is closely related to the Industrial Revolution and the process of urbaniz-

[5]I assume that facing asymmetric technological progress in favor of Modernists, Traditionalists do not abandon their mode of production despite its growing inefficiency. The persistence of inefficient economic behaviors is reported and explained in many papers like Grusec & Kuckzynski [1997] and Guiso et al [2006]. For instance, Salamon [1992] provides the example of German Catholics in 1840 United States. They adopted a less profitable way to exploit crops than Yankees and had more children on average.

ation (see Galor [2005a]). Two main explanations are relevant regarding empirical evidence on the fertility transition[6]. The first one lies in the evolution of the wage gap between men and women. Galor & Weil [1996] argue that the great technological progress characterizing the Industrial Revolution reduced the gender wage gap. Higher wages for women increased the opportunity cost of raising children, resulting in lower fertility rates and higher women's working time. The second main explanation lies in the increase in the demand for human capital. Galor & Weil's [1999] model helps explain the emergence of the Industrial Revolution and the Demographic Transition. The increase in the rate of technological progress induces a raise of both the parental wealth and the return of investments in children's human capital. As a result, parents substitute quality to quantity in their demand for children. This major contribution has been followed by papers exploring mechanisms reinforcing the impact of the rise in the demand for human capital on the parental fertility. The rise in life expectancy, changes in the marriage market, income inequalities, the decline in child labor and the natural selection[7] are among the most important ones.

The present contribution is more closely related to Galor & Moav [2002]. In their evolutionary analysis of the Industrial Revolution and the Demographic Transition, they also assume the existence of alternative valuation of children's quantity: there exist a group which is quantity biased and a group which is quality biased. In the first stage of the evolutionary process, quality biased agents keep an advantage from their higher investments in human capital. Indeed, economy lies in a Malthusian regime where fertility is positively related to income. As quality biased agents are wealthier, they are also more fertile what implies that their proportion increases.

[6] Other explanations challenge these two theories. The decline in infant and child mortality has been a major argument of demographers. Becker [1981] proposes that the increase of income is at the origin of the decrease in the fertility. However, these theories appear to be counter-factual (see Galor [2005b]).

[7] Galor [2005a, 2005b] provides a very enlightening review of this literature.

However, some externalities between groups imply that quantity biased families enjoy the rise in the average return of human capital investment. Then, they begin to invest in their children's quality and become wealthier. In turn, they increase their fertility which becomes higher than the quality biased agents' one. They finally become majoritarian.

In the present paper, cultural transmission is added to purely evolutionary processes. Indeed, contrary to Galor & Moav, I assume that the vertical transmission of preferences from parents to children is not perfect because it is cultural rather than genetic. Furthermore, there also exists an oblique transmission of preferences from the whole society to the children. Then, the model allows for mobility between groups. It implies that, when there exists an asymmetric technological progress in favor of Modernists (not necessarily a permanent one), the Traditionalist group, which is quantity biased, can disappear despite its "natural" advantage in the evolutionary process.

By considering cultural mobility rather than purely evolutionary processes, the present paper allows to consider the major role played, at least in Western Europe, by culture and norms in the relation between industrialization and the long run decrease of fertility[8].

1.2 Stylized Facts From Early Western Europe

The study of early fertility transitions in Europe from demographers and historians provides evidence linking the appearance of fertility transitions to urbanization, in-

[8]Recent and enlightening papers study the co-determination of culture and industrialization without considering fertility. Doepke & Zilibotti [2008] relate the Industrial Revolution to the transmission of patience among families and the development of financial markets. Galor & Ashraf [2007] propose a model of cultural assimilation and cultural diffusion to explain differences in the timing of the Industrial Revolution.

dustrialization *and* secularization[9]. Lesthaeghe & Wilson [1986] explore the fertility transition in Western Europe from 1870 to 1930. They find that the more Catholic the population is, the later the fertility transition. Furthermore, the extent of the agricultural production sector also delays the appearance of the fertility transition and slackens its pace. They argue that industrialization induces a fertility transition only if, in addition, an ethical transition makes births control acceptable.

Van Poppel [1985], Somers & Van Poppel [2003] and Van Bavel & Kok [2005] show that, in the Netherlands, the late fertility transition and the late industrialization are due to the predominance of Catholics and Calvinists who were actively opposed to modern limitation of births. Lesthaeghe [1977] studies the Belgian fertility transition. He distinguishes Walloons and Flemish. In both populations, the more industrialized and urbanized areas were also the more secularized ones. Interestingly, Walloons experienced an earlier fertility transition than Flemish. After controlling for the socioeconomic changes in both populations, Lesthaeghe finds that the remaining differences come from differences in secularization: Flemish were more attached to Catholicism which was opposed to births control.

All these studies agree that the dramatic changes in the occupational structure induced by the Industrial Revolution are a very important element to explain the decrease of fertility in Western Europe. However, they argue that secularization has been necessary to experience the fertility transition.

The present paper proposes a simple model enabling to reproduce this stylized fact. Traditionalists can be identified as Catholics and Calvinists. In compliance with their religious culture, they try to respect a high fertility norm and take part to a familial agricultural mode of production. Modernists are not influenced by

[9]In line with L. Berger [1973] and Lesthaeghe & Wilson [1986], the secularization is defined as a process depriving some aspects of the social and cultural life from the religious authorities.

religious institutions, their fertility choices are not shaped by explicit norms and they take part to the industrial sector.

Secularization of the population is represented by the long run decrease in the proportion of Traditionalists. Indeed, it makes the influence of religious norms decrease at the scale of the whole society. When the asymmetric technological progress in favor of industries is sufficiently strong[10], the population enters secularization and undergoes a fertility transition. However, this mechanism is conditional to the "intolerance" of Traditionalists[11] which partly results from the Church ideology. If this intolerance is very high, the population enters in secularization and decreases its average fertility rate much later and at a faster pace[12].

My results crucially come from two assumptions which are cornerstones of the paper: first, there exists a high fertility norm in the Traditionalist culture, second, Traditionalists are engaged in rural activities while Modernists are engaged in urban industries.

There exist a large set of evidence in favor of the existence of a high fertility norm in the Catholic and Calvinist cultures as well as in other major monotheistic religions[13]. Lesthaeghe & Wilson [1986], Somers & Van Poppel [2003] and Van Poppel [1985] find that practicing Catholics and Calvinists in Western Europe until the beginning of the second World War, are characterized by higher fertility rates than the rest of the population. Williams and Zimmer [1990], Adserá [2006] and

[10]The industrial bias of technological progress during the Industrial Revolution is well documented. See, for instance, Bairoch [1997].

[11]"Intolerance" has to be understood as the attachment of an agent to the perpetuation of its culture in his own dynasty. In this paper, Modernists also exhibit intolerance.

[12]See Van Heek [1956] for Holland. Appendix 1 provides evidence for Belgium where Flemish provinces are described as more attached to Catholics values which were opposed to births control.

[13]Evidence in favor of high fertility norms can also be found in Marxist ideologies like in China under Mao (see, for instance, Fan & Zhang [2000]) and in non-religious states like France (Spengler [1954]). Fernandez and Fogli [2007] show that culture is important to the understanding of female work and fertility without approximating culture by religion.

Amin et Al [1997] show that religiosity measured by church attendance has a positive and significant impact on fertility. With alternative measures, Janssen & Hauser [1981] and Hacker [1999] find the same result[14].

Lesthaeghe & Wilson [1986] indicate that high fertility rates in Catholic populations in early Western Europe come, in part, from the adequacy between the Catholic concept of familial solidarity and the labour intensive rural mode of production that was glorified by the Catholic Church. In religious families, children are a source of labor force, they take part in the familial production until they get married and start their own familial production. This adequacy between the Traditionalist culture and the familial mode of production is at the center of my second main assumption. Traditionalists are assumed to adopt a rural activity, namely a labor intensive agriculture or a family proto industry, and Modernists adopt an urban and industrialized activity[15]. For instance, Neven & Oris [2003] and Van Heek [1956] highlight this type of segmentation respectively for eighties century Belgium (especially in the Herve and Tilleur counties) and Holland (during the nineteenth century and beginning of the twentieth).

2 Description of the economy

2.1 The Model

The model consists of an overlapping generation economy where there are L_t adult agents who live for two periods. During the first period, they are children and only

[14] I assume that culture is a direct determinant of fertility. This is a simplification of a more complex phenomenon. The studies I mention, highlight a positive reduced form relationship between fertility and traditionalism (in its present definition). In reality, culture and fertility are observable behaviors that can be jointly determined by deeper variables like the socioeconomic structure. For example, in hunters gatherers societies, the origin of low fertility norms lies in the low productivity of their production technology that can only support a small population.

[15] Alesina & Giuliano [2007] find that strong family ties are associated with home production and higher fertility.

receive a "social education" from their parent. During the second period they are adults. They choose their optimal level of consumption C_t^i, the number of their children N_t^i and their social education τ_t^i which is understood as a socialization effort. Families are assumed to be monoparental. Childbearing is costly, each child takes a part $\eta^i > 0$ of its parent's time unit[16]. The cost of one unit of socialization is denoted by $\gamma > 0$. It follows that adults, at period t, have to respect the following budget constraint:

$$C_t^i + \eta^i \Omega_t^i N_t^i + \gamma \tau_t^i N_t^i = \Omega_t^i + \overline{\Omega} \tag{2.1}$$

Ω_t^i denotes the labor income of an agent of type i, its labor supply equals its remaining time after childbearing. $\overline{\Omega}$ denotes a non labor income which corresponds to a minimal domestic production assumed to be the same in all families[17]. Agents are culturally heterogenous in the sense that they could belong to different cultural groups. There are two cultures in the economy. The first one is the *Traditional* culture, it is characterized by a high fertility norm. Traditionalists are engaged in the agricultural sector providing an income Ω_t^T. The second culture is the *Modern* culture, Modernists are not influenced by fertility norms. They take part to the industrial sector providing an income Ω_t^M[18]. The proportion of Modernists at period t is denoted q_t, then $(1 - q_t)$ is the proportion of Traditionalists at that date.

A Modernist parent who has a Modernist child enjoys a utility denoted V_t^{MM}; if he has a Traditionalist child, he enjoys V_t^{MT}. A Traditionalist parent who has a Traditionalist child enjoys V_t^{TT}, and V_t^{TM} if he has a Modernist child. All things

[16] Hence, an agent of type i can have, at most, $\frac{1}{\eta^i}$ children. The cost of childbearing are different in the two cultures because of their specific mode of production. In compliance with empirical evidence of preceding sections, children are less costly in the rural agricultural production system than in the industrial sector. It follows that $\eta^M \geq \eta^T$.

[17] It ensures that a parent giving birth to the maximal number of children, can consume a positive amount of good.

[18] Note that Ω_t^T and Ω_t^M are exogenous.

being equal, parents prefer to have children adopting the same culture (traits) as their own but they altruistically prefer that their children become rich. Their children's future income is determined by their future culture: their income will be Ω_{t+1}^M if they become Modernist, and Ω_{t+1}^T if they become Traditionalist. Parents are characterized by static expectations, that is to say they expect their children will enjoy the same income as their own[19].Then:

$$\begin{array}{ll} V_t^{MM} = \theta^M + \Omega_t^M & V_t^{MT} = \Omega_t^T \\ V_t^{TT} = \theta^T + \Omega_t^T & V_t^{TM} = \Omega_t^M \end{array} \tag{2.2}$$

$\theta^i > 0$ denotes the supplement of utility a parent of type i enjoys when his child adopts the culture i. So θ^i represents the cultural intolerance of parents of type i. $\Delta V_t^i = V_t^{ii} - V_t^{ij} = \theta^i + \Omega_t^i - \Omega_t^j$ represents the loss for a parent of type i to have a child of type j. Then the loss of a parent, *in case of cultural deviation*, is equal to his cultural intolerance plus the potential loss of income for the child when he adopts the alternative culture. If the cultural deviation implies higher incomes, the relative importance of parental intolerance in the choice process decreases. Note that for very high values of Ω_t^j, ΔV_t^i can become negative.

The culture a child will adopt is not exogenously determined, it is the result of a socialization process à la Bisin & Verdier [2001]. A child is first exposed to the familial socialization. Socialization effort τ_t^i is a pure private good into the family in the sense that one unit of social education benefits to only one child. This assumption is a simplification of a more general framework in which socialization efforts can benefit to more than one child with decreasing returns such that total socialization costs would be concave in N_t^i. It simplifies the results without loss of accuracy.

[19]This simplification does not alter the results and make them more tractable. Indeed, the problem could be analyzed with rational (perfect) expectations. In this case, $\Delta V_t^i = \theta^i + E_t\left[\Omega_{t+1}^M - \Omega_{t+1}^M\right] = \theta^i + \left(1 + g_t^M\right)\Omega_t^M - \left(1 + g_t^T\right)\Omega_t^T$ with g_t^i the expected growth in sector i during period t.

Familial socialization succeeds with probability $(\tau_t^i)^{\frac{1}{2}} \in [0,1]$, the socialization effort exhibits decreasing returns for each child.

If the familial process of socialization fails, the child is engaged in a second stage of socialization where he is randomly matched with a role model in the society and adopts his traits. With probability q_t the child is matched with a Modernist and with probability $1-q_t$ with a Traditionalist. Transition probabilities can be expressed as follows:

$$\begin{array}{ll} P_t^{MM} = \left(\tau_t^M\right)^{\frac{1}{2}} + \left[1 - \left(\tau_t^M\right)^{\frac{1}{2}}\right] q_t & P_t^{MT} = \left[1 - \left(\tau_t^M\right)^{\frac{1}{2}}\right] \left[1 - q_t\right] \\ P_t^{TT} = \left(\tau_t^T\right)^{\frac{1}{2}} + \left[1 - \left(\tau_t^T\right)^{\frac{1}{2}}\right] \left[1 - q_t\right] & P_t^{TM} = \left[1 - \left(\tau_t^T\right)^{\frac{1}{2}}\right] q_t \end{array} \tag{2.3}$$

$P_t^{ij} \in [0,1]$ denotes the probability for a parent of type i to have a child of type j. The probability for a child to become Modernist (Traditionalist) increases with the proportion of Modernists (Traditionalists) in the economy. Finally, the utility of an agent of type i is denoted W_t^i and is described by[20]:

$$W_t^i(C_t^i, N_t^i, \tau_t^i) = C_t^i + \pi^i \left(N_t^i\right)^{\frac{1}{2}} + \left(N_t^i\right)^{\frac{1}{2}} \left[P_t^{ii} V_t^{ii} + P_t^{ij} V_t^{ij}\right] \; with \; \pi^i = \left\{ \begin{array}{l} 0 \; if \; i = M \\ \pi \; if \; i = T \end{array} \right. \tag{2.4}$$

Because Traditionalists belong to a culture characterized by high fertility norms, they give a higher value to children quantity than Modernists who only value quantity through their imperfect altruism. Higher values of π reflects higher fertility norms. There are two instruments for Traditionalists and Modernists to ensure their reproductive success in the long run: their fertility rate and their socialization effort. With a high fertility rate, a group ensures widespread implementation of its socialization process. So it can make a lower socialization effort per family to ensure

[20] As in Barro & Becker [1988], the parental utility function exhibits a constant elasticity with regard to the quantity of children. Here, for tractability, I assume that this elasticity equals one half. The linearity of utility with regard to consumption also consists in a simplification. It allows to obtain simple and tractable results which are in line with usual results of endogenous fertility models (see Galor [2005a]) and cultural transmission models (see Bisin & Verdier [2001]).

the same reproductive success as a group with a low fertility rate. Inversely, a group adopting a high socialization effort per family, needs a lower total fertility rate. The cultural and demographic dynamics are expressed respectively by equations (2.5) and (2.6) :

$$q_{t+1} = \frac{q_t N_t^M P_t^{MM} + (1-q_t) N_t^T P_t^{TM}}{q_t N_t^M + (1-q_t) N_t^T} \tag{2.5}$$

$$\frac{L_{t+1} - L_t}{L_t} = q_t N_t^M + (1-q_t) N_t^T - 1 \tag{2.6}$$

The proportion of modernists at period $t+1$ is equal to the number of children with Modernists parents ($q_t N_t^M$) who become also Modernists[21] plus the number of children with Traditionalist parents ($(1-q_t) N_t^T$) who become Modernists, divided by the number of Modernists in t. Equation (2.6) is simply the weighted average fertility rate minus one. Transition probabilities and fertility levels crucially depend on parental microeconomic choices described in what follows.

2.2 Individual Behaviors

Modernists

A Modernist parent born in $(t-1)$ chooses C_t^M, N_t^M and τ_t^M in order to maximize (2.4) subjected to (2.1) , (2.2) , (2.3) and $i = M$. I obtain the following decision rules:

$$N_t^{M*} = \begin{cases} \frac{1}{\eta^m} & if\ \Omega_t^M \leq \widehat{\Omega}_t \\ \left(\frac{q_t \Delta V_t^M + V_t^{MT}}{2\eta^M \Omega_t^M} \right)^2 & otherwise \end{cases} \tag{2.7}$$

$$\tau_t^{M*} = \begin{cases} 0 & if\ \Omega_t^M < \Omega_t^T - \theta^M \\ \frac{\eta^M}{4\gamma^2} \left[(1-q_t) \Delta V_t^M \right]^2 & if\ \Omega_t^M \in \left[\Omega_t^T - \theta^M, \widehat{\Omega} \right] \\ \left(\frac{\eta^M \Omega_t^M}{\gamma} \cdot \frac{(1-q_t)\Delta V_t^M}{q_t \Delta V_t^M + V_t^{MT}} \right)^2 & if\ \Omega_t^M > \widehat{\Omega}_t \end{cases} \tag{2.8}$$

[21] The law of large numbers does apply. So, the proportion of children with parents of type i who finaly become adults of type j is equal to P_t^{ij}.

with[22] $\widehat{\Omega}_t = \frac{q_t\theta^M + \{1-q_t\}\Omega_t^T}{2\{\eta^M\}^{\frac{1}{2}} - q_t}$. The value of $C_t^{M^*}$ is directly deduced from the budget constraint. The optimal fertility choice of a Modernist parent can be represented as follows:

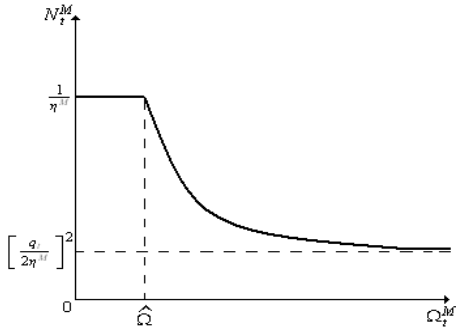


Figure 1 : Fertility of Modernists

For interior solutions, an increase in the Modernist earnings incites Modernist parents to increase their socialization effort and to decrease their fertility rate. Indeed, a higher value of Ω_t^M increases the parental income and the children's future income if they become modernists. Then the expected loss per child born for Modernist parents, *in case of cultural deviation*, increases. Then, they tend to implement a higher socialization effort to reduce that expected loss. The increase in the Modernist income has, *a priori*, a more ambiguous impact on the Modernists' fertility. Indeed, when Ω_t^M increases, the *total expected gain per child* increases[23], this has a positive effect on the parental fertility. However, as in standard endogenous fertility models, the cost of children's quantity increases with incomes. This has a negative impact on the Modernists' fertility. It is straightforward that, in the present framework, the negative impact is always the strongest one[24]. Notice that, when $\Omega_t^M \in \left[0, \widehat{\Omega}_t\right]$,

[22]Notice that, if $\Omega_t^T < \frac{2\eta^M}{2\eta^M - 1}\theta^M$, then $\widehat{\Omega}_t < \Omega_t^T - \theta^M \ \forall q_t$. It implies that the optimal socialization choice is: $\tau_t^M = \left(\frac{\eta^M \Omega_t^M}{\gamma} \cdot \frac{(1-q_t)\Delta V_t^M}{q_t \Delta V_t^M + V_t^{MT}}\right)^2$ if $\Omega_t^M > \Omega_t^T - \theta^M$ and 0 otherwise. Furthermore, if $\Omega_t^T < \theta^M$, ΔV_t^M can never be negative, then $\tau_t^M = 0$ in (2.8) never happens.

[23]Indeed, the expected utility of a child for a parent of type M equals $P_t^{MM} V_t^{MM} + P_t^{MT} V_t^{MT}$. When Ω_t^M increases, the utility of the child if he becomes modern (V_t^{MM}) will be higher. As I precedently mentioned, $\Delta V_t^M = \theta^M + \Omega_t^M - \Omega_t^T$ will also be higher.

[24]Formaly, $\frac{\partial N_t^m}{\partial \Omega_t^M} = -\frac{q_t\theta^M + (1-q_t)\Omega^T}{\left(\Omega_t^M\right)^2} < 0$

fertility is constrained and does not decrease, nevertheless socialization efforts increase.

The Modernists' socialization effort decreases with the proportion of Modernist parents. The vertical socialization (from parent) and the oblique socialization (from role models) are substitutes. When the parental socialization fails, a child with Modernist parents still has a chance to become Modernist if he is matched with a Modernist role model in the society. When q_t increases, the probability for any child to be matched with a Modernist role model becomes higher. Therefore the expected gain per child born increases and parents can reduce their familial (costly) socialization effort and have more children. Obviously, when q_t equals one, the probability for a child to be matched with a modern role model is one, then Modernist parents stop directly socializing their children, $\tau_t^{M*} = 0$. They allocate all their income to fertility and consumption.

Traditionalists

Traditionalists born in $(t-1)$ choose C_t^T, N_t^T and τ_t^T in order to maximize (2.4) subjected to $(2.1), (2.2), (2.3)$ and $i = T$. The optimal behavior of Traditionalist parents is described by[25]:

$$N^{T*} = \begin{cases} \left(\frac{(1-q_t)\Delta V_t^T + q_t\Omega_t^M + \pi}{2\eta^T\Omega_t^T}\right)^2 & if\ \Omega_t^M < \widetilde{\Omega}_t \\ \frac{1}{\eta^T} & otherwise \end{cases} \tag{2.9}$$

$$\tau_t^{T*} = \begin{cases} \left(\frac{\eta^T\Omega_t^T}{\gamma} \cdot \frac{q_t\Delta V_t^T}{(1-q_t)\Delta V_t^T + q_t\Omega_t^M + \pi}\right)^2 & if\ \Omega_t^M < \widetilde{\Omega}_t \\ \frac{\eta^T}{4\gamma^2}\left[q_t\Delta V_t^T\right]^2 & if\ \Omega_t^M \in \left[\widetilde{\Omega}_t, \Omega_t^T + \theta^T\right] \\ 0 & if\ \Omega_t^M > \Omega_t^T + \theta^T \end{cases} \tag{2.10}$$

With[26] $\widetilde{\Omega}_t \equiv \frac{\left[2(\eta^T)^{\frac{1}{2}} + q_t - 1\right]\Omega_t^T - (1-q_t)\theta^T - \pi}{q_t}$. Vertical and oblique socializations are still

[25] Results are displayed in function of the modernist income in order to simplify future reasoning. A more usual presentation would have consist in presenting the results in function of the Traditionalists' income. These results would have been symmetric to the modernists' ones.

[26] Notice that $\widetilde{\Omega}_t < \Omega_t^T + \theta^T\ \forall q_t \in [0,1]$ if $\eta^T < \frac{1}{4}$ what is assumed for the rest of the paper. This assumption fits the facts (see, for instance, De la Croix & Doepke [2003])

substitutes for Traditionalist parents. So an increase in q_t incites them to make less children and to implement a higher socialization effort. For interior solutions, an increase in the Traditionalists' earnings incites parent to substitute socialization effort to quantity of children. Notice that, because of the fertility norm , even if Traditionalists and Modernists would have the same fertility costs and the same income, Traditionalists' fertility would be higher than the Modernists' one.

Let consider that Traditionalists' income is high enough, such that, when the Modernists' income is low, their fertility and socialization choices are interior. When the Modernists' income increases, Traditionalists reduce their socialization effort and increase their fertility. Indeed, the loss resulting from the cultural deviation is smaller and the overall expected utility per child higher. When Ω_t^M reaches the threshold $\widetilde{\Omega}_t$, Traditionalists cannot increase their fertility anymore because they reached their maximum fertility rate. Then, they decreases their socialization effort without increasing their fertility. Finally, when Ω_t^M reaches $\Omega_t^T + \theta^T$, ΔV_t^T becomes negative and then Traditionalists stop socializing their children. Indeed, despite their cultural intolerance, they forecast that their children will be wealthier if they become Modernists. The evolution of the Traditionalists' socialization effort and fertility is described by:

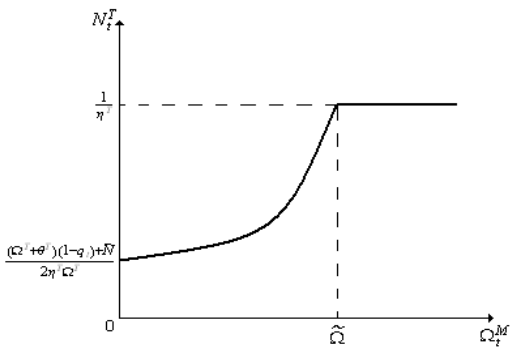


Figure 2: Fertility of Traditionalists

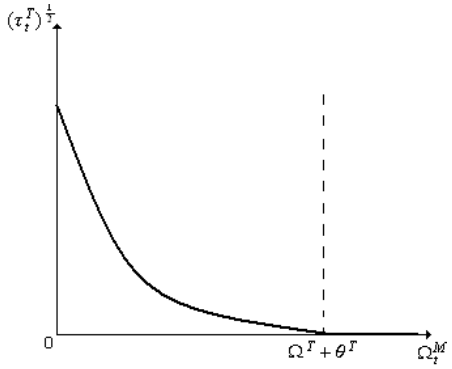


Figure 3: Socialization Effort of Traditionalists

Following these microeconomic results, the cultural and demographic dynamics of

the economy can be analyzed in the next sub-sections.

2.3 Cultural Dynamics

2.3.1 Multiple equilibria and cultural heterogeneity

The cultural dynamics of the population is given by equations (2.2) , (2.3) , (2.5) , (2.7) (2.8) , (2.9) and (2.10) . The presence of corner solutions depending on the value of Ω_t^M implies the existence of multiple regimes. The main properties of this dynamics are described in the following proposition.

Proposition 6 *(i) When* $\Omega_t^M \leq \Omega_t^T - \theta^M$, $q_t = \{0, 1\}$ *are the only existing steady states, and* $q_t = 0$ *is globally stable while* $q_t = 1$ *is unstable. (ii) When* $\Omega_t^M \geq \Omega_t^T + \theta^T$, $q_t = \{0, 1\}$ *are also the only existing steady states, however* $q_t = 0$ *is unstable while* $q_t = 1$ *is globally stable. (iii) When* Ω_t^M *takes intermediary values such that* $\Omega_t^M \in \left[\Omega_t^T - \theta^M, \Omega_t^T + \theta^T\right]$, $q_t = \{0, \overline{q}, 1\}$ *are the only existing steady states.* $q_t = \{0, 1\}$ *are unstable while the only interior steady state* $\overline{q}$ *is globally stable and allows for cultural heterogeneity.*

Proof. See Appendix 2. ■

Stability of the interior solution crucially comes from the substitutability between vertical socialization (from parents) and oblique socialization (from the whole society). All other things being equal, parents in the majority culture tend to make a smaller socialization effort than parents in the minority culture. It means that, for intermediary levels of inequalities between incomes of Modernists and Traditionalists, society is characterized by a long run cultural heterogeneity.

Notice that, in the interior regime (when $\overline{q}$ does exist), when Ω_t^M increases, the Traditionalist mode of production becomes inefficient relatively to the Modernist mode of production. However, the Traditionalist culture does not disappear. This

culture will disappear only when the inefficiency of its mode of production will be very high ($\Omega_t^M \geq \Omega_t^T + \theta^T$) such that members of this culture will choose stop transmitting their culture to their children. The reverse is also true, if the productivity of the Modernist mode of production is very low ($\Omega_t^M \leq \Omega_t^T - \theta^M$), the Modernist culture disappears in the long run.

2.3.2 Comparative statics

As a result, a rise in the Modernist productivity does not always increases the long run proportion of Modernists in the population. Indeed, it can easily be shown that the long run proportion of Modernists will increase after a positive shock on Ω_t^M if the following condition is fulfilled[27]:

$$\left(\frac{1}{2}\left[\tau_t^M\right]^{-\frac{1}{2}} N_t^M \frac{\partial \tau_t^M}{\partial \Omega_t^M} - \frac{1}{2}\left[\tau_t^T\right]^{-\frac{1}{2}} N_t^T \frac{\partial \tau_t^T}{\partial \Omega_t^M}\right) + \left(\left[\tau_t^M\right]^{\frac{1}{2}} \frac{\partial N_t^M}{\partial \Omega_t^M} - \left[\tau_t^T\right]^{\frac{1}{2}} \frac{\partial N_t^T}{\partial \Omega_t^M}\right) > 0 \tag{2.11}$$

The first term between parenthesis consists in the "cultural effect" and is positive while the second term between parenthesis consists in the "evolutionary effect" and is negative or equal to zero. Indeed, when the Modernist income increases, Modernists provide a higher socialization effort while Traditionalists reduce their own. However, when not constrained, Traditionalists increase their fertility while Modernists reduces their own. In other words, when Ω_t^M increases, Traditionalists get an advantage in the evolutionary process (the evolutionary effect) and Modernists get an advantage in the cultural transmission process (the cultural effect). The

[27] A proof is provided in Appendix 3.

following bifurcation diagrams represent the evolution of cultural steady states[28]:

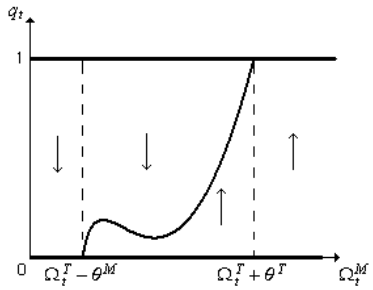


Figure 4: $\Omega^T > \theta^M$ and temporary domination of the evolutionary effect

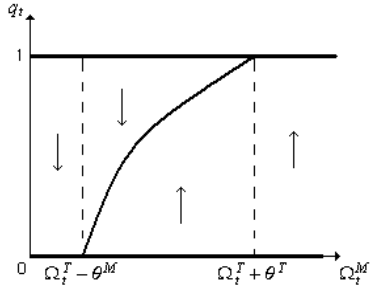


Figure 5: $\Omega^T > \theta^M$ and complete domination of the cultural effect

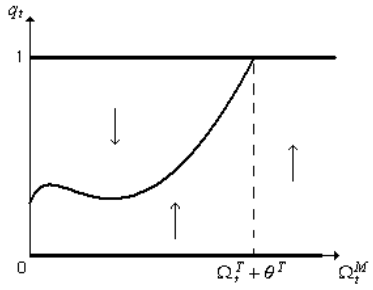


Figure 6: $\Omega^T \leq \theta^M$ and temporary domination of the evolutionary effect

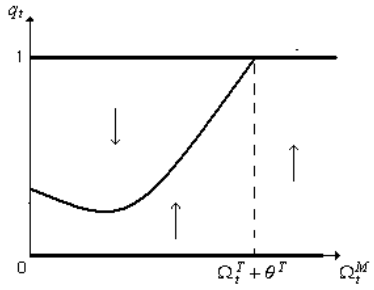


Figure 7: $\Omega^T \leq \theta^M$ and initial domination of the evolutionary effect

As mentioned in Proposition 1, $q_t = \{0, 1\}$ are always cultural steady states. Notice that when $\theta^M > \Omega^T$ (figure 6 and 7), the Modern culture will never disappear because Modernists will always prefer having Modernist children ($\Delta V^M > 0$). In $\Omega_t^M = \left\{\Omega_t^T - \theta^M, \Omega_t^T + \theta^T\right\}$, the cultural dynamics enters in bifurcations[29].

A rise in Ω_t^M implies an opposition between evolutionary and cultural processes. Nevertheless, it is intuitive that in the neighborhood of $\Delta V_t^M = 0$ and $\Delta V_t^T = 0$, the cultural effect always dominates the evolutionary effect. Indeed, when Ω_t^M becomes closed from $\Omega_t^T + \theta^T$, τ_t^T converges to zero because the loss of Traditionalists in case of cultural deviation (ΔV^T) will be closed to zero. Furthermore, the Modernists' fertility decreases but very slowly (see figure 1). So, for high values of the Modernist

[28] As shown in Appendix 2, wathever the values of $\widehat{\Omega}_t$ and $\widetilde{\Omega}_t$, the equation ensuring $q_{t+1} - q_t = 0$ is cubic in Ω_t^M. So, the variation of $\overline{q}$ can at most be also cubic. A last case has not been represented, it simply consists in the case where $\overline{q}$ is always increasing in Ω_t^M and $\Omega^T > \theta^M$.

[29] Indeed, when $\Omega_t^M < \Omega_t^T - \theta^M$, $q_t = 0$ is a stable steady state whereas it becomes unstable when $\Omega_t^M > \Omega_t^T - \theta^M$. In the same way, when $\Omega_t^M < \Omega_t^T + \theta^T$, $q_t = 1$ is an unstable steady state whereas it becomes stable when $\Omega_t^M > \Omega_t^T + \theta^T$.

income, the evolutionary effect does not play a role anymore (see equation (2.11)). In the same way, when Ω_t^M is in the neighborhood of $\theta^M - \Omega_t^T$, ΔV_t^M tends to zero. So, τ_t^M also tends to zero and decreasing returns in the familial socialization implies that the cultural effect is strong. Furthermore, for low values of the Ω_t^M, the Modernists' fertility is constrained (see figure 1), $\frac{\partial N_t^M}{\partial \Omega_t^M} = 0$.

However, for intermediary values of Ω_t^M, the evolutionary process can dominate the cultural process. In this case, an income shock in favor of Modernists may finally reduce the long run proportion of Modernists.

2.3.3 Cultural Dynamics after a productivity shock in favor of Modernists

This sub-section illustrates the impact of a biased technological shock on the cultural dynamics. I show how an improvement in the modernists' wealth does not always increase their proportion in the population. In the following graphics, I represent the evolution of q_t given its initial value q_0 and the interplay between evolutionary and cultural processes after an income shock:

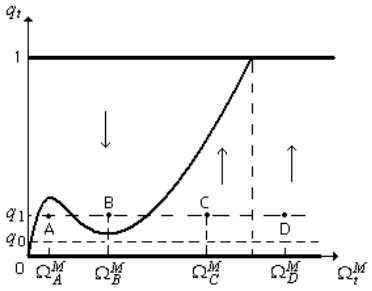


Figure 8: Effect of a shock on Ω_t^M

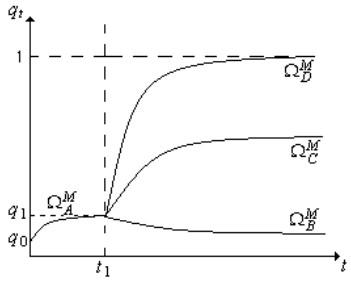


Figure 9: Cultural Dynamics in function of the shock's magnitude

In this example, the biased productivity shock in favor of Modernists arises when q_t equals q_1. Three shock's magnitude are proposed. For a "small shock" increasing Ω_t^M from Ω_A^M to Ω_B^M, the long run cultural dynamics is dominated by evolutionary effects. In other words, the rise in the fertility differential in favor of Traditionalists more than compensates the rise in the socialization differential in

favor of Modernists. So, after the biased income shock, the proportion of Modernists decreases toward its low long run level. For an intermediary shock (from Ω_A^M to Ω_C^M), the cultural effect dominates the evolutionary effect. Then, q_t converges to a long run value which is higher than q_1. Notice that, in this case, the long run cultural heterogeneity is ensured because the income shock has not been very strong. However, when Ω_t^M increases from Ω_A^M to Ω_D^M, the wealth gap between the two groups is so high ($\Omega_t^M - \Omega_t^T > \theta^T$) that Traditionalists stop directly socializing their children. Then, q_t converges to 1 and there is no long run cultural heterogeneity into the population.

It finally appears that a sufficiently strong asymmetric technological progress ensures the cultural homogenization of the population. Such a biased technological progress has not to be permanent, it only has to be such that $\Omega_t^M - \Omega_t^T > \theta^T$ until q_t converges to one. At this time, Traditionalism has definitely disappeared. It also intuitive that a stronger attachment of Traditionalists to their culture will make Traditionalism surviving for higher income shocks. This will be further discussed in the following sections but it is obvious that, if θ^T takes higher values, the wealth gap between the two modes of production ($\Omega_t^M - \Omega_t^T$) has to be higher.

2.4 Population Dynamics: Scenarii for a Fertility Transition

In this sub-section, I propose some scenarii that could occur after a rise in the wealth gap between Modernists and Traditionalists. To do so, rather than assuming a single discrete shock on Ω_t^M, I assume a progressive adjustment. In other words, I assume that there exist a transitory biased technological progress in favor of Modernists. Doing so, the description of the fertility rate's evolutions will be more precise.

It is intuitive that, if the biased technological progress is sufficiently strong, a fertility transition is inevitable. Indeed, as shown in figures 4 to 8, a strong increase

in Ω_t^M finally rises the long run proportion of Modernists who reduce their fertility while it reduces the proportion of Traditionalists who cannot indefinitely increase their fertility (see figure 2). The decrease in the Total fertility rate occurs even if Traditionalism does not completely disappear and well before the disappearance of Traditionalists if Ω_t^M becomes higher than $\Omega_t^T + \theta^T$. Indeed, at the latest, when the Traditionalists' fertility becomes constrained because of the income gap (see figure 2), the Total Fertility Rate unambiguously decreases. Furthermore, the convex relation between N_t^M and Ω_t^M implies that the effect of the reduction in the Modernists' fertility is initially strong.

Empirical evidence (see Galor [2005b]) indicate that, in the beginning of the demographic transition, total fertility rate can increase. This stylized fact can easily be reproduced by the model but with a different mechanism than in the usual literature. Indeed, if the fertility of Modernists is initially constrained because of their low income (see figure 1), the increase in their income will not initially incite them to reduce their fertility. However, Traditionalists increase their fertility because their total expected utility per child increases. Then, as long as the Modernists' fertility remains constrained, the asymmetric technological progress make the average Total Fertility Rate increasing. When the Modernists' fertility is no more constrained, two polar scenarii can be envisaged. In the first one, the income converges to a relatively low value where the evolutionary effect dominates the cultural effect (as B in figure 8). Then, the economy remains trapped in a traditionalist regime where the average Total fertility Rate is high. In the second case, Ω_t^M converges to a relatively high value (as in D), then the average Total Fertility rate will unambiguously decrease. Indeed, Traditionalism progressively disappears and the Modernist fertility decreases.

The model also generates situations where the Total fertility Rate decreases as soon as the asymmetric technological progress does appear. Indeed, when the Modernists' fertility is not initially constrained and the income shocks leads to situation where the cultural process dominates (like C or D), the reduction in the Modernists' fertility can immediately overwhelm the increase of the Traditionalists' one.

For higher values of θ^T, the homogenization of the society ($q_t = 1$) will require stronger asymmetric income differences. For a given technological progress, the rise in the long run proportion of Modernists will be slower. Indeed, when Traditionalists are more intolerant with regard to their children's cultural deviation, they are less sensible to the improvement of wealth their children could enjoy if they became Modernists. Then, when Ω_t^M increases, they reduce less their socialization efforts. The completion of the fertility transition will be longer.

Describing the exact evolution of the Total fertility rate requires a numerical example. Indeed, Total Fertility Rate depends on Ω_t^M in a complex way because it directly depends on Ω_t^M but also on the cultural dynamic path which also depends on the evolution of Ω_t^M.

3 Numerical Example

This numerical example aims at illustrating the impact of an exogenous growth of the Modernist income Ω_t^M and the influence of Traditionalism on the long run population dynamics. It will appear that the long run decrease of fertility is the by product of two phenomenon: the long run disappearance of Traditionalists and the decrease in the Modernist fertility. Furthermore, a high degree of Traditionalism can delay the appearance of the fertility transition but accelerate its pace once it is engaged.

3.1 On the Cultural and Demographic Transitions

Two main numerical examples are proposed in this section. In the first one, $\theta^M \leq \Omega^T$ what implies that for $\Omega_t^M < \Omega^T - \theta^M$, ΔV_t^M will be negative. In the second numerical example, $\theta^M > \Omega^T$ such that ΔV_t^M will never be negative, furthermore $\Omega_0^M > \widetilde{\Omega}_0$. These two exercises hold the following parametrization:

Case 1: $\theta^M \leq \Omega^T$	Parameters' Values	Case2: $\theta^M > \Omega^T$
160	Ω^T	80
40	Ω_0^M	40
100	θ^T	100
100	θ^M	100
10	$\overline{N}$	10
15	$\overline{\Omega}$	15
60	γ	60
0,2	η^T	0,2
0,35	η^M	0,35
0,2	g^M	0,2
0,41	q_0	0,2

Table 1: Values of Parameters for the Alternative Exercises

$g^M = \frac{\Omega_{t+1}^M - \Omega_t^M}{\Omega_t^M}$ denotes the exogenous asymmetric technological progress in favor of the Industrial mode of production. The value of 0,2 is closed to the average annual output growth in Western Europe since 1820 (see Bairoch [1997]). For simplicity, this technological progress is not assumed to be transitory but permanent. In other words, given g^M and Ω_0^M, the homogenization of the population is inevitable. Accordingly to $\eta^T = 0,2$ and $\eta^M = 0,35$, the maximal number of children per family is 10 for Traditionalists and somewhat closed from 6 for Modernists. As mentioned in the first sections, this difference comes from the alternative status of children in the two mode of productions: children are more costly in urban areas than in rural areas. γ is calibrated such that socialization probabilities belong to $[0, 1]$. The initial income of Modernists is chosen such that, when $\theta^M \leq \Omega^T$, ΔV_t^M can be negative in the beginning of the growth process of Ω_t^M. The two exercises leads to the following

cultural and demographic dynamics[30]:

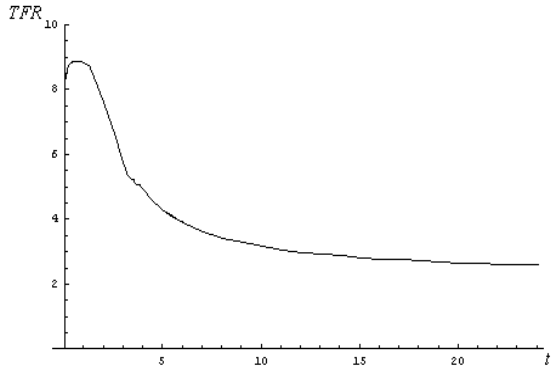


Figure 10 : Dynamics of Fertility in case 1

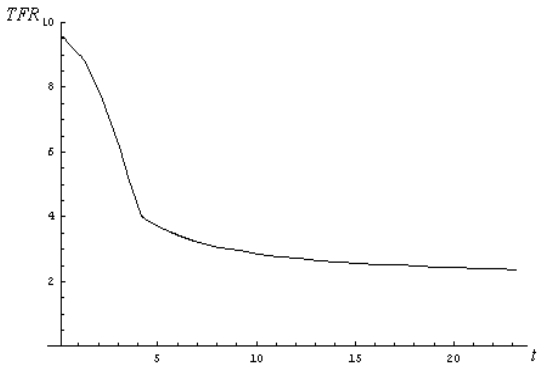


Figure 11 : Dynamics of Fertility in case 2

In the first exercise (figure10), ΔV_t^M is initially lower than zero. Then, until Ω_t^M reaches $\widetilde{\Omega}_t$ (in approximately one period), the Total Fertility Rate increases because the Modernists' fertility remains constant while the Traditionalists' one increases (for $\Omega^T = 160$, it is not initially constrained). This effect is reinforced by the rise in the proportion of Traditionalists in the whole population until ΔV_t^M becomes positive. When Modernists engage in socialization, their proportion increases while their fertility begins to decrease. Then, a fertility transition does appear.

In the second exercise (figure 11), Ω^T is such that ΔV_t^M can never be negative. Furthermore, the initial values of q_t and Ω_t^M implies that the Traditionalists' fertility is always constrained ($\Omega_0^M > \widetilde{\Omega}_0$ when $q_0 = 0,41$). As mentioned in preceding sections, in this case, they cannot increase their fertility when the Modernists' income increases. Then, they only decrease their socialization effort. Furthermore, as ΔV_t^M is always positive, Modernists increase their socialization effort and decrease their fertility (once Ω_t^M reaches $\widehat{\Omega}_t$). As q_0 is low and the evolutionary process never dominates the cultural process, the proportion of Modernists is always increasing and the Total Fertility Rate always decreasing

[30]The model being formulated in discrete time, the evolution of the Total Fertility Rate has been artificially smoothed.

3.2 Impact of Traditionalism

It finally appears that, in this model, fertility transition results from two phenomenon: a cultural transition making the long run proportion of Modernists growing and a decrease in the Modernists' fertility because of the improvement of their income. A central result of the present paper lies in the fact that the cultural transition is a necessary condition to undergo a fertility transition. The growth of productivity and income (of Modernists) is not sufficient. Indeed, in the present exercise, I propose to simulate the demographic dynamics of the economy for different values of the Traditionalists' attachment to their culture, namely θ^T, for case 1 of the preceding sub-section:

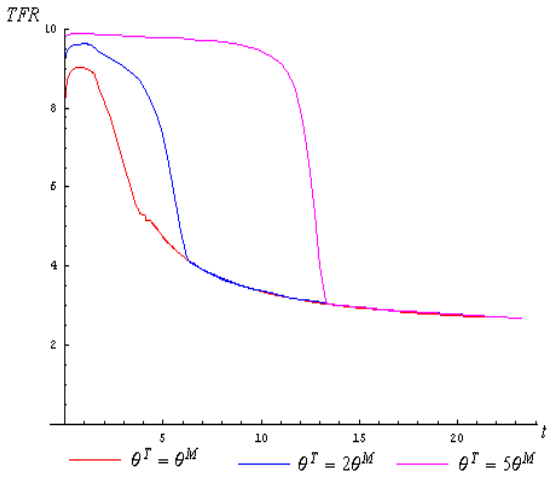


Figure 12: Impact of θ^T on the Fertility Dynamics

As a general result, a higher degree of Traditionalism implies a higher initial Total Fertility Rate and a later but faster fertility transition. As shown in section 3, when θ^T is strong, the marginal return of the quantity of children is higher. It implies that, for the same initial values of Ω_t^M and q_t, the initial Total Fertility Rate is higher. Furthermore, a higher θ^T implies that Traditionalists are less sensible to the wealth improvement their children could enjoy if they become Modernists. Then, when Ω_t^M increases, they reduce less their socialization effort than for low values of

θ^T. It implies that the proportion of Traditionalists in the population remains high in the beginning of the income growth process. In other words, the "cultural effect" is weaker when the Traditionalists' intolerance is higher.

Finally, Traditionalism induces a delayed cultural transition and so a delayed fertility transition (see figure 12). An initially more Traditionalist society needs more favorable economic conditions in the Modernist mode of production to engage the long run reduction of fertility.

Furthermore, once fertility begins to decrease, societies with a higher degree of Traditionalism experience a faster decrease of its Total Fertility Rate. This simply comes from the fact that the cultural transition is delayed. Indeed, it does appear for higher values of the Modernists' income. Then, when Modernists become majoritarian, their fertility is already very low. Then, for a similar increase in q_t, the Total Fertility Rate decreases more rapidly.

Notice that the decrease of fertility in Modernists families comes from the rise in the industrial productivity and so in their income. Introducing a standard quality quantity trade-off would have lead to the same results: a rise in the marginal return of the Modernists' education investment would incite them to substitute quality to quantity. The future income of Modernists would be increasing what incites Modernists parents to increase their socialization efforts[31].

4 Conclusion

In this paper, I propose a model which enriches the economic analysis of the fertility transition by integrating some cultural aspects of the process. I show that a fertility

[31] No dynastic analysis would be possible because each individual would be characterized by a specific situation depending on its familial cultural and economic history and on his own cultural choice. Cultural and economic heterogeneity would make analytical analysis non tractable. Then, a rigourous numerical methodology would be essential to understand the model's main implications.

transition results from an asymmetric technological progress in favor of the industrial sector and a cultural transition making cultures limiting births majoritarian. Such a cultural transition will occur because cultural deviation from traditional to modern groups is more enjoyable when asymmetric technological progress takes place. As a result, if Traditionalist agents are widely attached to their culture, they will be less sensible to this asymmetric shocks and maintain high efforts to make their culture survive despite its growing inefficiency. This mechanism allows to explain the deletion of a fertility transition in more Traditionalist countries as in early Belgian Flanders and Holland.

The consideration of cultural aspects in the dynamics of reproductive behaviors begins to greatly benefit from the more general renewal of cultural analysis in economics. In order to continue the rehabilitation of the Synthesis Model of fertility, it will be crucial, in future work, to make the long run evolution of social norms (at least regarding fertility) themselves endogenous, in a quantifiable and therefore testable manner.

Appendix 1

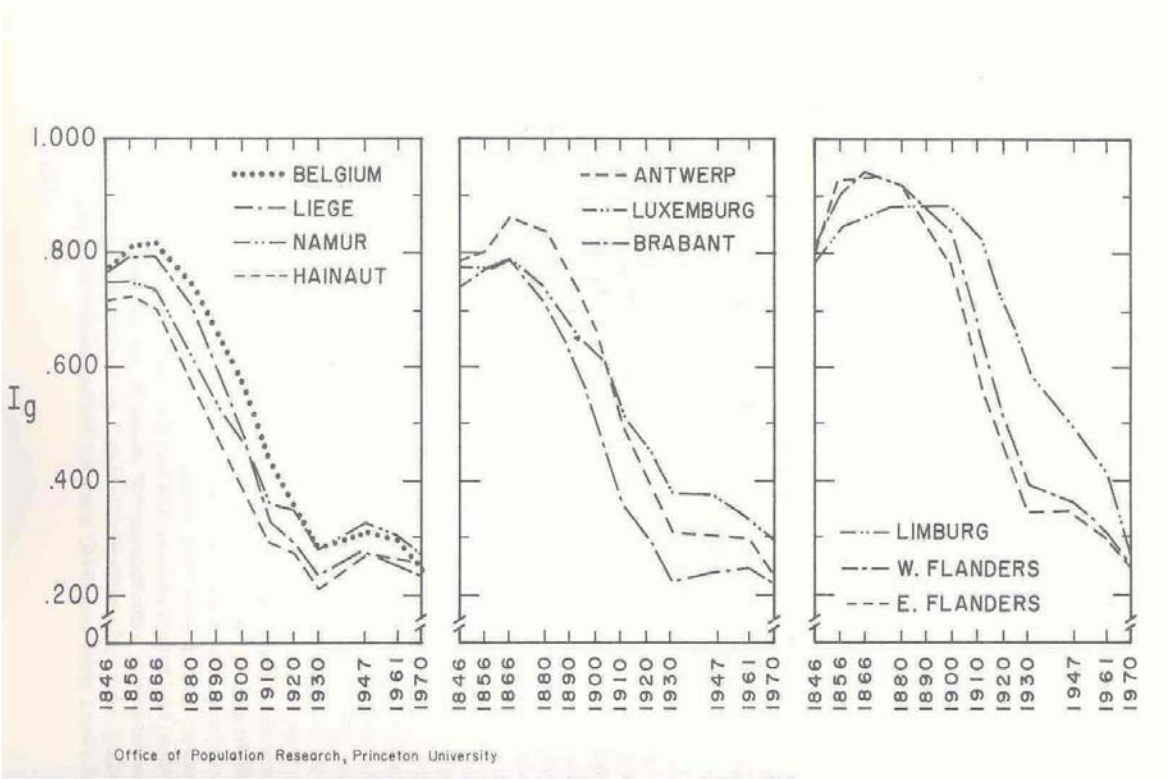


Figure 12: Marital Fertility by Province in Belgium from 1846 to 1970 from Lesthaeghe [1977]

Appendix 2

To proof Proposition 6, I propose four lemmas. Lemma 7 aims at proving that non interior steady states are unstable when there exist interior steady states. Lemma 8 shows that only one non interior steady states is stable when there is no interior one. Lemmas 9 and 10 show that there exist, at most, one interior steady state. These four lemmas combined with properties of the model will allow to prove Proposition 6. As shown in section 3, τ_t^M,τ_t^T, N_t^M and N_t^T are all functions of q_t. They are now respectively denoted by $\tau_t^M(q_t)$,$\tau_t^T(q_t)$, $N_t^M(q_t)$ and $N_t^T(q_t)$.

Lemma 7 *If* $\tau_t^M(1) = 0$, $\tau_t^T(1) > 0$, $N_t^M(1) \geq 0$, $N_t^T(1) > 0$ *and* $\tau_t^M(0) > 0$, $\tau_t^T(0) = 0$, $N_t^M(0) > 0$, $N_t^T(0) \geq 0$, *then* $q_t = \{0, 1\}$ *are both unstable steady states of the cultural dynamics at the competitive equilibrium and there exist, at least, one*

interior and stable cultural steady state if $q_{t+1} - q_t$ *is continuous in* q_t.

Proof. It follows from (2.3) and (2.5) that:

$$\frac{\partial[q_{t+1}-q_t]}{\partial q_t} = \frac{\left[q_t N_t^M + (1-q_t) N_t^T\right]\left[(1-2q_t) A_t^{MT} + q_t(1-q_t)\frac{\partial A^{MT}}{\partial q_t}\right] - q_t(1-q_t) A_t^{MT}\left[N_t^T + N_t^M + (1-q_t)\frac{\partial N_t^T}{\partial q_t} + q_t\frac{\partial N_t^M}{\partial q_t}\right]}{\left[q_t N_t^M + (1-q_t) N_t^T\right]^2} \tag{2.12}$$

With $A_t^{MT} = \left(\tau_t^M\right)^{\frac{1}{2}} N_t^M - \left(\tau_t^T\right)^{\frac{1}{2}} N_t^T$. A solution to (2.5) will be a stable steady state if and only if, at this point, $\frac{\partial[q_{t+1}-q_t]}{\partial q_t} \leq 0$. It follows from (2.12) that: $\left.\frac{\partial[q_{t+1}-q_t]}{\partial q_t}\right|_{q_t=0} = \frac{A_t^{MT}\big|_{q_t=0}}{N_t^T(0)}$ and $\left.\frac{\partial[q_{t+1}-q_t]}{\partial q_t}\right|_{q_t=1} = -\frac{A_t^{MT}\big|_{q_t=1}}{N_t^M(1)}$. If $\tau_t^M(1) = 0$, $\tau_t^T(1) > 0$, $N_t^M(1) \geq 0$, $N_t^T(1) > 0$ and $\tau_t^M(0) > 0$, $\tau_t^T(0) = 0$, $N_t^M(0) > 0$, $N_t^T(0) \geq 0$, then $\left.\frac{\partial[q_{t+1}-q_t]}{\partial q_t}\right|_{q_t=0} > 0$, and $\left.\frac{\partial[q_{t+1}-q_t]}{\partial q_t}\right|_{q_t=1} > 0$. It finally implies that $q_t = \{0,1\}$ are unstable steady states. So, if $q_{t+1} - q_t$ is continuous in q_t, there exist, at least, one interior stable steady. ■

Lemma 8 *If* $\Delta V_t^M \leq 0$, *then* $q_t = \{0,1\}$ *are the only steady states of* (2.12). *Furthermore,* $q_t = 0$ *is globally stable and* $q_t = 1$ *is unstable. If* $\Delta V_t^T \leq 0$, *then* $q_t = \{0,1\}$ *are the only steady states of* (2.12). *Furthermore,* $q_t = 0$ *is unstable and* $q_t = 1$ *is globally stable.*

Proof. From (2.8), if $\Delta V_t^M \leq 0$, $\tau_t^M = 0\ \forall q_t \in [0,1]$. It follows that $\forall q_t \in [0,1]$:

$$q_{t+1} - q_t = -\frac{q_t(1-q_t)\left(\tau_t^T\right)^{\frac{1}{2}} N_t^T}{q_t N_t^M + (1-q_t) N_t^T} < 0 \tag{2.13}$$

By (2.7),(2.9) and (2.10), it is obvious that (2.13) is continuous in q_t. (2.13) implies that : there does not exist any interior steady state, $\left.\frac{\partial[q_{t+1}-q_t]}{\partial q_t}\right|_{q_t=0} < 0$ and $\left.\frac{\partial[q_{t+1}-q_t]}{\partial q_t}\right|_{q_t=1} > 0$. It follows that $q_t = 0$ is unstable and $q_t = 1$ is globally stable.

With the same method, from (2.10), $\forall q_t \in [0,1]$, if $\Delta V_t^T \leq 0$, $\tau_t^T = 0$ and:

$$q_{t+1} - q_t = \frac{q_t(1-q_t)\left(\tau_t^M\right)^{\frac{1}{2}} N_t^M}{q_t N_t^M + (1-q_t) N_t^T} > 0 \tag{2.14}$$

By (2.7),(2.8) and (2.9), it is obvious that (2.14) is continuous in q_t. (2.14) implies that : there does not exist any interior steady state, $\frac{\partial[q_{t+1}-q_t]}{\partial q_t}\Big|_{q_t=0} > 0$ and $\frac{\partial[q_{t+1}-q_t]}{\partial q_t}\Big|_{q_t=1} < 0$. It follows that $q_t = 0$ is unstable and $q_t = 1$ is globally stable. ■

Lemma 9 *If A_t^{MT}, N_t^M, N_t^T are continuous in q_t and $\forall q_t \in [0,1]$, $\left(N_t^M, N_t^T\right) > (0,0)$, then $q_{t+1} - q_t$ is continuous in q_t at the equilibrium.*

Proof. This is straightforward because, by (2.3), (2.5) can be written as follows:

$$q_{t+1} - q_t = \frac{q_t(1-q_t)\left[\left(\tau_t^M\right)^{\frac{1}{2}} N_t^M - \left(\tau_t^T\right)^{\frac{1}{2}} N_t^T\right]}{q_t N_t^M + (1-q_t) N_t^T} \tag{2.15}$$

■

Lemma 10 *If: (a) A_t^{MT} is quadratic in q_t, (b) $\tau_t^M(1) = 0$, $\tau_t^T(1) > 0$, $N_t^M(1) \geq 0$, $N_t^T(1) > 0$ and $\tau_t^M(0) > 0$, $\tau_t^T(0) = 0$, $N_t^M(0) > 0$, $N_t^T(0) \geq 0$, (c) A_t^{MT}, N_t^M, N_t^T are continuous in q_t and $\forall q_t \in [0,1]$, $\left(N_t^M, N_t^T\right) > (0,0)$ and (d) $\left(\Delta V_t^M, \Delta V_t^T\right) > (0,0)$, there exist only one interior steady state $\overline{q} \in]0,1[$ which is globally stable.*

Proof. By Lemmas 2 to 4, it is obvious that there exist an impair number of steady states between $q_t = 0$ and $q_t = 1$ when $\left(\Delta V_t^M, \Delta V_t^T\right) > (0,0)$. From (2.15), $\forall q_t \in]0,1[$, $q_{t+1} - q_t = 0$ if and only if $A_t^{MT} = 0$. If A_t^{MT} is quadratic in q_t, $A_t^{MT} = 0$ has at most two real solutions. Then, there exist only one interior steady state $\overline{q} \in]0,1[$. By Lemma 2 and 4, it straightforward that $\frac{\partial[q_{t+1}-q_t]}{\partial q_t}\Big|_{q_t=\overline{q}} < 0$. Then $\overline{q}$ is globally stable. ■

From (2.7), (2.8), (2.9) and (2.10), it appears that, whatever the values of $\widehat{\Omega}$ and $\widetilde{\Omega}$, when $\Omega_t^M \in \left]\Omega^T - \theta^M, \Omega^T + \theta^T\right[$, A_t^{MT} is a quadratic of q_t. From Lemmas 7, 8 and 9, there exist a unique interior cultural steady state $\overline{q}$ which is globally stable. From Lemma 8, when $\Omega_t^M \leq \Omega_t^T - \theta^M$, $q_t = \{0,1\}$ are the only existing steady states, and $q_t = 0$ is globally stable while $q_t = 1$ is unstable. Also from Lemma 8, when

$\Omega_t^M \geq \Omega_t^T + \theta^T$, $q_t = \{0, 1\}$ are also the only existing steady states, however $q_t = 0$ is unstable while $q_t = 1$ is globally stable.

Appendix 3

From Appendix 2, $\overline{q}$ is the unique interior solution of $A_t^{MT} = 0$. Because A_t^{MT} depends on both q_t and Ω_t^M, it directly follows that:

$$\left.\frac{dq_t}{d\Omega_t^M}\right|_{q_t=\overline{q}} = -\left.\frac{\frac{\partial A_t^{MT}}{\partial \Omega_t^M}}{\frac{\partial A_t^{MT}}{\partial q_t}}\right|_{q_t=\overline{q}} \tag{2.16}$$

From Proposition 6, $\left.\frac{\partial A_t^{MT}}{\partial q_t}\right|_{q_t=\overline{q}} < 0$ when $\Omega_t^M \in \left]\Omega^T - \theta^M, \Omega^T + \theta^T\right[$. Then, $\left.\frac{dq_t}{\partial \Omega_t^M}\right|_{q_t=\overline{q}} > 0 \Leftrightarrow \left.\frac{\partial A_t^{MT}}{\partial \Omega_t^M}\right|_{q_t=\overline{q}} > 0$. Differentiating A_t^{MT} with respect to Ω_t^M leads to the following condition:

$$\left(\frac{1}{2}\left[\tau_t^M\right]^{-\frac{1}{2}} N_t^M \frac{\partial \tau_t^M}{\partial \Omega_t^M} - \frac{1}{2}\left[\tau_t^T\right]^{-\frac{1}{2}} N_t^T \frac{\partial \tau_t^T}{\partial \Omega_t^M}\right) + \left(\left[\tau_t^M\right]^{\frac{1}{2}} \frac{\partial N_t^M}{\partial \Omega_t^M} - \left[\tau_t^T\right]^{\frac{1}{2}} \frac{\partial N_t^T}{\partial \Omega_t^M}\right) > 0 \tag{2.17}$$

Chapter 3

Religion and Fertility: The French Connection

Introduction

Usual microeconometric studies of fertility, in France, suffer from a lack of data on religion. The aim of this chapter is to overcome this shortcoming by providing a microeconometric investigation of the French fertility where, for the first time to the best of my knowledge, religion is taken into account. Furthermore, beyond this religious dimension, I provide complementary proxies for culture like the transmission of family values from parents to children.

As mentioned in the general introduction, the economic analysis of fertility behaviors enriched with microeconomic foundations since the seminal approach of Becker *et al* [1960, 1973, 1976]. The Beckerian theory assumes that children are time consuming, especially for women. It implies that higher female income results in smaller fertility rates[1]. The household theory of fertility[2] shows that an increase in the income of women reduces their fertility while an increase in the male income increases the household total fertility rate (TFR). Indeed, a higher male income reduces the opportunity cost for the woman not to participate to the workforce[3]. These standard mechanisms have largely been evidenced by empirical studies without including cultural variables[4]. This absence of cultural determinants was essentially due to the lack of datasets allowing to clearly identify and measure cultural variables.

Thanks to the recent development of rich datasets including both economic and cultural variables, economists are now able to properly measure the impact of culture on fertility[5]. Doing so, they can test the validity of the usual Beckerian con-

[1] Becker & Tomes [1976] also argue that an increase in the parental income incite parents to have less children better educated because the income elasticity of demand for quality is higher than the income elasticity of demand for quantity.

[2] See, for instance, Browning *et al* [2006] for a review of this literature.

[3] See, for instance, Galor & Weil [1996] and Bourguignon *et al* [1995].

[4] See Schultz [2008] and Hotz *et al* [1993] for a review of this literature.

[5] See Guiso *et al* [2006] for a review of this literature.

clusions in a framework where culture matters. In the present chapter, I provide a contribution to this recent literature. Controlling for usual economic variables like the respondent's incomes and education, I investigate cultural determinants of individual fertility on a French sample.

Religion is often chosen by the literature to identify and measure culture[6]. Guiso *et al* [2006] argue that "*religious practices, even when they respond to economic conditions, are modified over time only at centuries or even millennium frequency. In this spirit, we restrict our attention (...) to those cultural aspects like religion and ethnic background that can largely be treated as invariant over an individual's lifetime*"[7].

French laws make it very difficult to collect data on the individual's religious affiliation. If religion had no impact on fertility behaviors, this specificity would not weaken the analysis of individual fertility behaviors in France. In line with the recent literature, this chapter shows that this is not actually the case.

Several studies directly deal with the religious dimension of culture. The investigation of the religions' role in fertility behaviors essentially tries to answer two questions: "Are there any differences in fertility behaviors between religions?" and "Does religiousness influence fertility?" Few evidence support the existence of time persistent differences in fertility rates between the main monotheistic religions (see

[6]Fernandez and Fogli [2007] show, without using religious variables, that culture is important to the understanding of female work and fertility decisions. They observe the economic behavior of immigrants in the United States during the second half of the twentieth century. They consider the expected female labor force participation and their total fertility rate, for the year 1950 in the immigrant's country of origin, as a good proxy for culture. It reflects their country's cultural attitude toward women's labor and fertility. They find that the cultural proxy is an economically and statistically significant variable to explain women's labor force participation and their total fertility rate. This epidemiological method could not be applied in the French case because informations about ethnic origin or country of origin cannot be collected.

[7]Birdsall [1988] argues, following Easterlin [1978] and Easterlin *et al* [1980], that fertility behaviors are influenced by social norms. She mentions that "*these norms may change in response to economic factors, but they are viewed as changing slowly enough so that for individual couples within a given society they can be considered as exogenous to fertility*"

Brañas-Garza & Neuman [2006]).

Religiosity, however, appears to be a significant determinant of fertility. Neuman & Ziderman [1986] find that, among Jews, religiousness (measured by time devoted to religious activities) strongly and significantly increases fertility. Heineck [2006] studies the link between religion and fertility in Austria. He finds that women who are "strong Catholic believers" are expected to have larger families than woman without any religious belief.

Hacker [1999] shows that the degree of Christian conservatism is a good proxy for religious sentiment for American-born white women in the nineteenth century. Conservatism is measured by a dummy variable indicating whether individuals belong to specific religious groups such as Congregationalists, Universalists, Lutherans or Catholics. He finds that this proxy has a significant effect on women's fertility: more conservatism implies a higher total fertility rate.

Williams and Zimmer [1990], Adserá [2006] , Amin *et al* [1997] show that the religiousness measured by church attendance has a positive and significant impact on fertility[8].

France is a secularized country with a Catholic identity. It was the first European country to enter the secularization process. Furthermore, the proportion of Catholics practicers keeps dramatically decreasing since 1945. This process quickened during the seventies. In 2001, the proportion of French individuals who had at least one element of Catholic practice[9] per month is about 12% (Hervieu-Léger [2004]). This makes intuitive that religiousness should have a relevant impact on individual fertility (see Adsera [2006]).

[8]Note that Brañas-Garza & Neuman [2006] find that, among Spanish catholics, the exposure to religious practice during childhood has a positive impact on fertility. They also find that current religiosity of the respondent has no effect on fertility. However, the exposure to religious practice during childhood and current religiosity are strongly correlated.

[9]Either going to church, going to cathechism, confession, etc.

The dataset "Enquête Mode de Vie des Français" is the first opportunity to measure the impact of religion and religiousness on fertility in France. It provides precise measures for religion like to be a Believer or not, church attendance, individuals' estimation of the importance of religion in their own life[10]. This dataset is also rich of numerous informations about the respondent's economic situation (incomes, savings, wealth, history on the labor market, etc.), his lifestyle (health, addictions, consuming habits, etc.), his risk aversion and his values (religion, politics, attitude toward foreigners, etc.)

Several dimensions of religion are investigated in the present chapter. As in the usual literature, I explore the impact of the adherence to a religion, of believing (to be a religious believer or not) and of religiousness on fertility. I find that having been raised in a specific religion has no effect on expected fertility. Defining oneself as a religious believer has, *a priori*, a positive and significant impact on individual fertility. Nevertheless this effect loses its significance when the degree of religiousness is introduced. This latter is finally the only religious variable that really matters for fertility. This result is validated whether religiousness is measured by church attendance or by the respondent's subjective evaluation of the importance of religion in his own life. This last measure is innovative in the literature.

Culture is not investigated only through the impact of religion on fertility. Indeed, I explore two aspects of the cultural transmission into the family: the influence of parental fertility on the own respondent's fertility and the transmission of "Family Ties / Family Oriented Values"[11] among generations. I find that these two chan-

[10]Notice that, as the main purpose of this dataset was not the study of fertility behaviors, some relevant informations are missing. Particularly, the absence of information on children's education makes it impossible to investigate the quality quantity trade-off chosen by parents. Furthermore, children's date of birth are not reported. It prevents the study of the impact of family policies on fertility choices and the examination of births spacing behaviors.

[11]From French "Le sens de la Famille". I will refer to Family Oriented Values during the rest of the chapter.

nels are as important as religious variables to explain fertility. Indeed, having been raised in a large family significantly increases the repondent's expected fertility. The interpretation of this result is not straightforward. Bisin & Verdier [2001] underline the possibility that parents transmit their preferences to their children through a socialization process. Then, the effect of the variable "parental fertility" could reflect some transmission of the parental taste for fertility but it could also reflect alternative transmissions from parents to children like social position and location. Nevertheless, this variable allows to control my results for these effects.

I also find that respondent's who have been raised in a family with "strong family ties" have significantly more children than others. Family ties are measured by replies to the following questions: "Which of the following values do you (or would you) try to transmit to your children?" and "Among the same set of values, which ones did your parents transmit you?" Respondent have been allowed to choose three answers among twelve like "Independency", "Taste for Work", "Generosity", Happiness", "Honesty", "Family Values", etc. A respondent who choose "Family Values" for one of the questions gets one, he gets two if he chooses it for the two questions and zero otherwise[12]. I find that this score variable, called "Family Oriented values", has a positive and significant impact on the respondent's fertility.

I control my results for the respondent's familial background. Obviously, never having been married strongly decreases expected fertility. Among the conclusions of usual family economics (see Behrman [1993]), I find that male income has a positive impact on female fertility whereas the female income has a negative impact.

[12] Alesina & Giuliano [2007] find that strong family ties are associated with higher fertility with a different method. They measure family ties with individual responses from the World Value Survey "*regarding the role of the family and the love and respect that children need to have for their parents*" for over 70 countries. They show that strong family ties implies a relatively stronger reliance to home production than to labor market participation. It results in lower labor force participation of women and higher fertility.

The women's education negatively influences fertility[13] in the sense that the least educated women have more children than others. The respondent's age is the most powerful explanatory variable for the high frequency of observations where fertility equals zero. It highlights the strong postponement of first births which is a common characteristic of all developed countries. Furthermore, the woman's education and the size of the city where she lives both have a significant impact on the decision not to have children: highly educated women from big cities are more likely to choose not having children than other women.

The rest of the chapter is organized as follows. Section 2 provides a brief overview of the French fertility. Section 3 describes the data set "Enquête Mode de Vie des Français". Section 4 discusses the estimation method and presents its main results. Section 5 proposes some robustness checks. Finally, Section 6 concludes.

1 A Brief Overview of The French Fertility

The French fertility has been the first to decrease in early Europe in the eighteenth century. It started to decrease even before mortality. This feature has often been mentioned to invalidate the traditional theory of the demographic transition which presents the decrease of mortality as the main reason for the long run fall in fertility (Galor [2005a]). France has also been the first European country to enter secularization. This has favored the adoption of modern methods of birth control and notably contraception (Lesthaeghe & Wilson [1986] and Kirk [1996]). Lesthaeghe [1977] underlines that the proximity of the French culture was one of the main determinant of the earlier and faster fertility decrease in Wallonia than in Flanders.

As in all European countries, after the Second World War, fertility in France

[13]This result also appears in Schultz [1999], Breierova & Duflo [2004], Hoem *et al* [2006]. Note that less conclusive results are find by Kravdal [2004] and McCrary & Royer [2006].

has been relatively high until the seventies. In 1970, the total fertility rate was very close to 2,5 children per women. Since 1964, the French fertility had decreased and reached its lowest level, in a period of peace[14], at 1,66 children per women in 1993. As displayed on figure 1, since 1994, this rate has always been increasing to reach 1,98 in 2006.

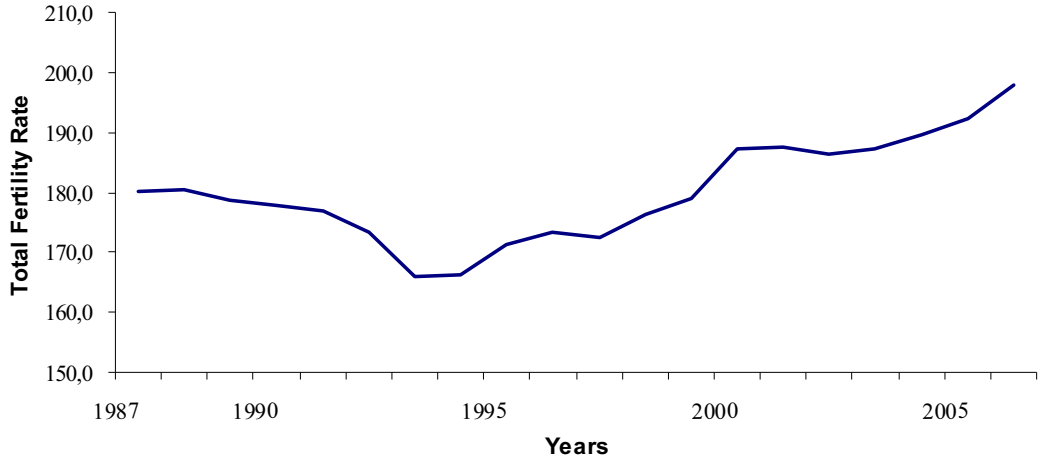


Figure 1: French Total Fertility Rate since 1987 (US Census Bureau)

In 1994, the French family policies became more generous. Subsidies for births particularly raised for families who decide to have a third child. Furthermore, strong efforts have been made to provide day nurseries and to reduce the cost of child care by sitters. These policies succeeded in allowing French women to have children without renouncing to their career[15]. Brewster & Rindfus [1996] and Apps & Rees [2004] argue that such public policies decrease the child rearing time of parents (and especially women) and in turn, incite households to have more children and women to increase their labor supply. A large literature highlight that public policies are one of the main determinant of the persistence of high fertility rates in France[16]. For

[14]During the First World War, the French fertility rate reached its minimum at 1,23 in 1916.

[15]Indeed, in France like in other European countries, the relationship between fertility and women's participation to the labor market is now positive (see Ahnand & Mira [2002]).

[16]Prioux [2007] provides an enlightening presentation of fertility evolutions in France for the last

instance, Lauer & Weber [2003] and Köppen [2006] show that French women have both more children and higher participation to the labor market than German women. They find that differences in family friendly policies are the main determinant of this differential fertility.

Toulemon *et al* [2008] argue that the family policies in France have created especially positive attitudes towards two or three child families. Such policies have largely enjoyed a consensus among politicians and French residents. Laroque & Salanie [2005] also find that financial incentives have been efficient in increasing the fertility in France.

If the current French fertility rate is below its replacement level, it is the highest among European countries since 2002 (see figure 2). France is expected to increase its population up to 65,7 million people in 2050 while the German's population is expected to decrease in the same time. If this happens, Germany's population would stay the largest in Europe and the French population the second largest one. Due to larger fertility, ageing is expected to be lower in France, it implies that the proportion of the French population in Europe is expected to raise from 16 to 17%[17].

thirty years.

[17]Europe is understood here as countries from the European Union in 2006. Data from Robert-Bobée [2007] (INSEE)

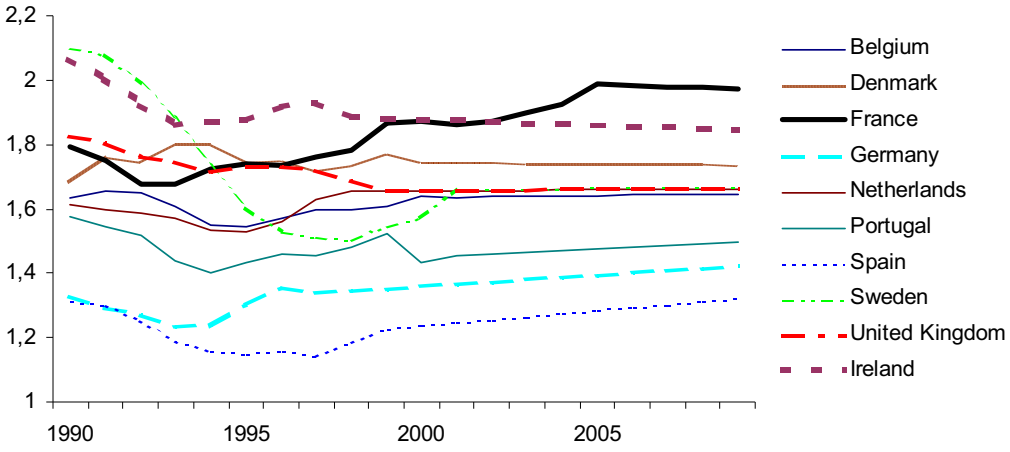


Figure 2: TFR in European Countries since 1990 (US Census Bureau)

2 Data and Strategy of Estimation

Data come from the sample "Enquête Mode de Vie des Français" for the year 2007. It consists in a sample of 3826 French agents aged between 18 and 93. The population is constituted of 2080 women and 1746 men. Only women are considered in the present study. The main reason lies in the fact that men and women do not experience the same pattern of fertility throughout their life. Women can only procreate during a limited period of time while men are not biologically limited. Furthermore, the measurement of women's fertility is less sensible to measurement errors. After having deleted missing observations, the subsample is reduced to 1793 observations. Notice that, for robustness checks, the data set will be extended to men.

The sub sample's total fertility rate equals 1,6 children. Among the 1793 women, 466 do not have children while only 121 have more than three children. The average age is about 48. 219 women are less than 28 years old and 952 are more than 45 years old. 1500 have been raised in a Catholic family while only 988 consider themselves

as believers and 540 are considered as practicers[18]. Finally, 849 women from the selected sample are currently married.

To measure the impact of religion, it is important to discriminate between the adherence to a specific religion and the religiousness. In the present study, the religious affiliation of agents is divided between major religions (Catholics, Muslims, Protestants, Jews...). It refers to their response to the question: "In which religion have you been raised?". Their actual faith is measured by their response to the question: "Are you a believer?".

As in Williams and Zimmer [1990], Adserá [2006] , Amin *et al* [1997], the degree of religiousness is first measured by attendance to religious office. The variable "Office Frequency" goes from zero to five. It equals to one if he announces never going to religious office and five if he goes to office at least once a week. It increases with the respondent's frequency of attendance to offices. For robustness checks, another measure of religiousness is provided: people were asked to evaluate the importance of religion in their own life from zero to ten.

The sample is not reduced to women who have completed their fertility as, for instance, in Fernandez & Fogli [2007] and Breierova & Duflo [2004]. This allows the sample size to be larger and to extend the study to a higher number of generations. If religion has not the same impact on all the generations of women, restraining the analysis to older woman could lead to biased estimations. One could oppose that current and achieved fertility do not describe the same phenomenon. However, during robustness checks, the sub sample of women who have achieved their fertility is studied.

As not all women in the sample have completed their fertility, it is obvious

[18] An individual is considered as a Practicer if she declares frequently attending religious offices in addition to religious festivities.

that the age of the respondent has a strong influence on her fertility. The older a woman, the higher her fertility. This partly comes from the postponement of the first birth. Furthermore, women older than 45 are expected to have completed their reproduction process.

Directly introducing the age of the respondent sensibly increases the overall fit of the model. The effect of age reflects, however, much more complex phenomena than the simple position of the respondent in her "reproductive process"[19]. Indeed, age also reflects important cohort effects. During the second half of the twentieth century, France has experienced, among other great transformations, a generalization of education, at least one profound modification in family policies (1994), a strong decrease in the influence of Catholicism, a liberalization of the marriage market and a diversification of the forms of unions. The standard deviation of age is about 16 years. A difference of 16 years between two women can explain their differences in fertility because they are not in the same position in their reproductive process but also because they have experienced differences in the quality of the education system, in family policies, in the prevalence of religious norms in the whole society, etc.

Only the position in the reproductive process is used in the regressions. This is called the "dummies strategy" where I control my results for less than 28 and more than 45 years old. This makes the interpretation of the effect of age easier. Notice that these dummies also capture cohort effects but these latter will be easier to identify. The results are also provided when the age is directly introduced in the regressions (See Table 7). The impact of proxies for cultural transmission inside the

[19]By assumption, a woman can be in one of the following situation: not fertile (less than 16 years old, not usefull here), fertile but younger than the average age at first birth (28 for France in 2006), fertile and older than the average age at first birth and in the "completed fertility position" (older than 45 by assumption).

family and for religiosity are always validated.

Women from the entire sample are not necessarily married because, once again, reducing the analysis to married women would induce the presence of a selection bias[20]. Indeed, doing so, I would measure the impact of religion and cultural transmission among married French women and not among French women. It can reasonably be expected that married woman are not characterized by the same sensitivity toward religion and familial values than non married women. I obviously control my results for the respondent's situation on the marriage market.

Family economics argue that female's education and incomes play a major role in the determination of optimal fertility. Two dummies are provided to control if the respondent has only a primary education level or an university level. At least two variables have to be considered to represent income: the female income and the male income. The dataset contains informations on the respondent's annual net income and on the total household income. Then income of male can easily be inferred[21]. Notice that an endogeneity bias can be suspected. Indeed, fertility and income can have common determinants which are not taken into account in the present paper. For example, one can expect that subsidies for day nurseries increase both fertility and incomes (higher labor force participation). This problem will be investigated during robustness checks.

Fertility at the micro level consists in a count variable. Long & Freese [2006] underline that count data have to be analyzed with Poisson regressions or Negative Binomial regressions in order to avoid any doubt of inconsistency and inefficiency. Individual data on fertility structurally exhibit a zero inflated distribution. This

[20] This choice is also made, for instance, by Young [2007] and Miranda [2008].

[21] Notice that, as in Fernandez & Fogli [2007], Melkerson & Rooth [2000], Miranda [2008], etc., reported incomes are current incomes whereas endogenous fertility models deal with life cycle income. As in these contributions, my results are controlled by education and age of the respondent in order to limit this weakness.

characteristic comes from both the postponement of first birth in developed countries and the increase of childlessness since the second World War. In France, the average age at first birth was very close from 28 in 2006. The following regressions make it clear that the zero inflated Poisson regression model should be preferred to a simple Poisson regression model and to a zero inflated negative binomial regression model.

Several robustness checks are implemented. Their goal is to verify wether religion and proxies for cultural transmission really have an impact on fertility. To do so, an alternative measure of religiousness is provided. Furthermore, alternative samples are studied: women being older than 45 and the entire population. This allows to suppress any doubts about the effect of sample selection on the relation between religion and fertility. To check robustness for assumptions on the distribution, an ordered probit regression was run as in Fernandez & Fogli [2007]. An OLS regression is also provided. All robustness checks indicate that religion and transmission of values inside the family are relevant to explain fertility in France.

3 Results

The assumption that fertility is distributed following a Poisson distribution would result in the following probability of having $y_i = n$ children:

$$\Pr\left[y_i = n \mid x_i\right] = \frac{e^{-\mu_i}\mu_i^n}{n!}$$

where $\mu_i = \exp\left(x_i\beta\right)$ with x_i the individual characteristics. However, individual fertility data often exhibit an excess of zero observations. So in order to take into account the high number of zero in the data set, a Zero Inflated Poisson (ZIP) regression model is proposed[22]. This method allows to explain both the number of

[22]Long & Freese [2006] provide a very simple and enlightening presentation of the method to obtain the zero inflated Poisson regression model.

children born (with a Poisson model) and the decision not to have children (with a Logit model).

The probability (η_i) for an individual to belong to the group exhibiting a zero count (G^0) is represented by a Logit model:

$$\eta_i = \frac{e^{\delta_i z_i}}{1 + e^{\delta_i z_i}}$$

where z_i are the variables explaining the decision to have children and δ_i the estimated parameters. If an individual belongs to the zero group ($G^0 = 1$), her estimated fertility is always zero. If she does not belong to the zero group ($G^0 = 0$, with probability $1 - \eta_i$), her fertility is assumed to be distributed following a Poisson distribution. Then, her probability to have $n \geq 0$ children equals $\Pr[y_i = n \mid x_i] = \frac{e^{-\mu_i}\mu_i^n}{n!}$. Finally, the assumed distribution for count fertility is sensibly different from the Poisson regression model. Indeed, the overall probability for a zero count is:

$$\Pr[y_i = 0 \mid x_i,\ z_i] = \eta_i + (1 - \eta_i)\Pr[y_i = 0 \mid x_i, G^0 = 1]$$

And the probability for a positive count is:

$$\Pr[y_i = n > 0 \mid x_i,\ z_i] = (1 - \eta_i)\Pr[y_i = n > 0 \mid x_i, G^0 = 0]$$

Obviously, this modified Poisson distribution increases the probability to have a zero count compared to a standard Poisson regression model. As the Poisson regression model and the zero inflated regression model are not nested, to determine if the distribution really exhibits an excess of zeros, a Vuong test [1989] is run. The Vuong statistics[23] indicate that the Zero inflated Poisson regression model should be preferred to the Poisson regression model.

[23] Vuong statistics are reported in Table 1.

In order to clearly determine the impact of religion and cultural transmission, a step by step zero inflated Poisson regression model is implemented (see Table 1). In a first regression (Model 1), neither religious nor cultural variables are considered. In a second regression (Model 2), the variables describing the cultural transmission from parents to children are introduced. These variables describe the parental fertility of the respondent and the transmission of family oriented values into the family. In Model 3, I introduce the variable "No Religion" describing if the respondent has been raised in a religious family[24]. In Model 4, the variable "Believer" is added. It equals one if the individual answers "Yes" to the question: "Are you a Believer?". The variable "Office Frequency" measures the respondent's religiousness. It increases from 1 to 6 in function of her attendance to religious offices.

In the present sample, the high number of zero counts is explained by the respondent's age (postponement of first births), the size of her town and her "higher education status". The older a woman is, the lower her probability to have no child. Furthermore, a woman who has engaged in higher education and does not live in a small town has a higher probability to choose not having children.

Alternative regressions for the excess of zero have been tested (see Table 3 in appendix). I find that never having been married has no impact on the decision not having children. This result confirms that limiting the study to married woman could bias the estimation of the impact of cultural background on fertility. Religiousness and having only low education levels have no significant impact on the probability to be childless.

As shown in Model 2, to have been raised in larger families significantly increases the respondent's fertility. Furthermore, the transmission of family oriented values

[24]It takes value one if the respondent has been raised in a religion. Notice that the sample suffers from a selection bias in the sense that other non catholic religions are under represented. Then differences between religions cannot be investigated.

among generations also increases fertility.

Another major result lies in the fact that having been raised in a religious family and proclaiming to be a religious believer do not significantly increase expected fertility[25] (see Table 1). Indeed, in model 4 (Table 1), the variable Believer was, a priori, significant because, putting alone, it brings out two dimensions of the religious background: believing and practicing (religiousness). This is confirmed when religiosity is added in the regressions (see model 5). Finally, religiousness measured by the frequency of offices attendance is the only religious variable which significantly influences fertility.

Following these results, Model 6 indicates that an increase of one standard deviation in the Office Frequency increases the estimated fertility of the respondent by a factor of 1.044. In other word, the estimated fertility of a woman with the maximal religiousness is 24% higher than the expected fertility of a woman without any religiousness. It has to be noticed that the introduction of religious variables does not weaken the impact of proxies for the transmission of fertility patterns and family oriented values inside the family.

The Bayesian Information Criterion (BIC) indicates that Model 6 is very strongly preferred to Model 5. This confirms that both having been raised in a specific religion and being a believer are meaningless to explain fertility behaviors. Following Raftery [1996], the BIC indicates a positive evidence in favor of Model 6 against Model 1 but not a strong evidence. As Model 1 and 6 are nested, a Likelihood Ratio (LR) test can be run. It appears that Model 6 should be strongly preferred to Model 1[26].

[25]The sample suffers from a selection bias in the sense that alternative religions are under represented in the sample. Then specific religious affiliation cannot be tested as a determinant of fertility.

[26]The null-hypothesis is that the coefficient of Office Frequency, Parental Fertility and family Values are all equal to zero. The probability to prefer model 6 against model 1 while model 1 fits better the distribution than model 6 equals to 0,0002.

Usual predictions of Family economics are also validated. Income of men and women have opposite effects. The income of the woman has a negative impact on her fertility whereas the income of the man has a positive impact. This tends to confirm that opportunity costs of fertility are essentially determined by the woman's income. This interpretation is conditional on the assumption that mothers have to invest a higher part of their time in child rearing. In line with the results of Ahn & Mira [2002], this effect is expected to be smaller in France than in some other European countries like Germany, Greece and Italy. Indeed, the French infrastructures and fiscal scheme allow women to conciliate a strong participation to the labor market and high fertility.

The impact of school attainment has a significant impact on expected fertility only for less educated women. Indeed, fertility of a woman who has only achieved primary education is 19,1% higher than a woman who has achieved a high school graduation. Women with an university level have a stronger probability not having children but, when they decide having children, their fertility behavior is not significantly different from women who only have a high school diploma.

Finally, women younger than 28 exhibit a lower fertility than others. Indeed, in 2006, the average age of entry in fertility for French woman was 28. Furthermore, women older than 45 are expected to have achieved their reproduction process. In consequence, they mechanically tend to have more children than women who have not yet achieved their reproductive process. Notice that, as mentioned in the preceding section, this effects are also suspected to derive from some cohort effects[27]. However, the fact that the effects of the position in the reproductive process are in

[27]Particularly, the generous family policies implemented in France since 1994 have sensibly increased fertility. This could have altered the impact of the variable "More Than 45 yo" because the group of women being older than 45 embodies the group of women who achieved their reproductive process without enjoying generous subsidies for fertility.

adequacy with intuition, indicates that the cohort effects are not too strong.

The following section provides some robustness checks. It checks that the significant role of the cultural background in the Poisson regression model does not come neither from the assumptions on the distribution nor from the chosen measure of religiousness.

4 Robustness Checks

The following subsections test the robustness of my results with regard to assumptions on the distribution, endogeneity of the female income, the measure of religiousness and the sample selection.

4.1 Overdispersion and Alternative distributions

This subsection provides robustness checks for the distribution. The estimation of count data with a Poisson or Zero Inflated Poisson regression model can be subject to overdispersion. Looking at the summary values, it appears that the sample's variance (1,762) is greater than its mean (1,582). To test for overdispersion[28], a zero inflated Negative Binomial regression model is provided. The negative binomial regression model allows the variance of the distribution to be greater than its mean: $V(y \mid x_i) = \alpha E(y \mid x_i)$. An LR test for the assumption $\alpha = 0$ is proposed. The probability of rejecting $\alpha = 0$ when this is true equals to 0,938. As the data set is not subjected to overdispersion, the zero inflated Poisson regression model should be preferred[29].

[28] In case of overdispersion, the standard errors in the PRM will be biased downward, resulting in spuriously large z-values and spuriously small p-values (Cameron and Trivedi [1986]).

[29] Because $\alpha = 0$ with a very strong p-value, regressions are not reported. Indeed, values of estimated parameters are indentical in the two regressions. Their only differences lie in the z-statistic for the inflation term which are smaller in the zero inflated negative binomial regression model than in the zero inflated poisson regression model. Nevertheless, significance of each variable remains unchanged.

Fernandez & Fogli [2007] analyze fertility data at the micro level using ordered probit regressions. I also use this method to test the impact of cultural background on fertility in addition to Ordinary Least Squared (OLS) regressions[30]. The ordered probit regression model (Table 2) also indicates that having been raised in a religious family and being a believer have no impact on fertility. LR test for nested model and differences in BIC indicate that the model which includes the religiousness variable (office frequency), the parental fertility and the Family Value variable is preferred to the two other ordered probit models. Expected differential fertility between woman with the maximal religiousness and women without religiousness is about 20%.

In Table 2, OLS regressions also conclude that the model which excludes the variables No Religion and Believer should be preferred to other OLS models. The OLS regressions provide results which are closed to the zero inflated Poisson regression model and the ordered probit model.

These regressions confirm that the significance of the relation between religion, cultural transmission and fertility, is not dependent on my assumption on the distribution.

4.2 Endogeneity Bias and Instruments for Female Income

The Beckerian models of fertility show that fertility and income find common determinants like the cost of the quantity of children which determine both the female fertility and her participation to the labor market. If the female income is endogenous, it would be correlated with errors and result in some inconsistency. In this subsection, I propose to investigate this question in the framework of OLS models. As previously shown, OLS regressions provide satisfying results in comparison to zero inflated Poisson and probit models. Dealing with OLS allows to apply simple

[30] Long & Freese [2006] underline that count data can sometimes be analyzed with OLS regression.

methods to address endogeneity.

I first perform a Durbin-Hausman-Wu test of endogeneity[31] for the female income which shows that the female income is endogenous. Indeed, the Durbin-Hausman-Wu statistics indicate that the probability to accept exogeneity of the female income while it is endogenous in reality, equals 37,6%. Following this result, I propose to instrument the women's income by the variables "Financial Expert" and "Bank Loan"[32].

The variable "Financial Expert" comes from the answer to the following question: "When you have to make a financial investment, do you consult a Financial Expert?" Respondents have to choose between three answers: "Often", "Sometimes" or "Never"[33]. One can reasonably expect that the answer to this question is negatively correlated with income because it is relied on the frequency and amounts of savings but not with fertility. Indeed, consulting financial expert tells nothing about the risk aversion of the respondent. So it is not suspected to be related to prudence or risk taking which could be, however, related to fertility.

The variable "Bank Loan" comes from the response to the following question: "If you needed money, do you expect that you could borrow it to a bank?" As for "Financial Expertise", the *expectation about bank loan* is suspected to be correlated with income but not with the fertility choice[34].

Regressions are provided in Table 4 in appendix. As expected, the variables "Financial Expertise" and "Bank Loan" both have a negative and significant im-

[31] This test was first proposed by Durbin [1954] and separately by Wu [1973] and Hausman [1978].

[32] I choose to use two instruments rather than only one because it allows to run Sargan and Difference in Sargan tests for the exogeneity of instruments. Indeed, the Difference in Sargan test (Hansen Sargan test) is a test of overidentifying restrictions (see Wooldridge [2000]).

[33] The variable "Financial Expert" equals to one if the respondent chooses "Often", to two if he chooses "Sometimes" and to three if "Never". Then "Financial Expert" is expected to be negatively correlated with income.

[34] The variable "Bank Loan" equals one if the answer is "No" and zero if "Yes". Then "Bank Loan" is expected to be negatively correlated to the respondent's income.

pact on income (see "female income regression" in Table 4). Furthermore, after its instrumentation, female income still has a significant negative impact on expected fertility while male income has a positive one. Notice that coefficients of "Primary Education" and "Parental Fertility" and "Office Frequency" still have the same sign but are now smaller. Furthermore "Office Frequency" is now significant at the 5% confidence level and "Primary Education" and "Parental Fertility" at the 10% one. I provide Sargan and Difference in Sargan statistics to test the exogeneity of my instruments. These tests conclude that these latters are satisfying at the 5% confidence level (see Table 4).

Finally, in the OLS framework, there exist an endogeneity bias for female income. After a correction for this bias, the effects which I determined in the precedent section, remain robust[35].

4.3 An alternative Measure of Religiousness

The data set provides an alternative measure of the respondent's religiousness. It consists in the answer to the question "Between 0 and 10, how do you evaluate the importance of religion in your own life?". This variable is subject to some caveats. Indeed, it consists in a subjective variable while the frequency of church attendance is an objective criterion. Two respondents can have the same religious behavior but different subjective estimates of the importance of religion. An absolute notation makes interpretations harder because differences in evaluations are less objective than differences in church attendance. To weaken this limitation, a variable "Estimated Religiousness" is constructed. It equals: (i) 1 if the respondent's answer belongs to [0,3], (ii) 2 if his answer belongs to [4,6] and (iii) 3 if it belongs to [7,10].

[35]Ideally, this method should be applied to the poisson regression model. However, it is confronted to a problem of convergence of the estimators.

The variable "Office Frequency" has been replaced by the variable "Estimated Religiousness" in the zero inflated Poisson regression model and in the ordered probit regression model (see Table 5 in appendix). In the zero inflated Poisson regression model, "Estimated Religiousness" has a significant positive impact on fertility when the variables "No Religion" and "Believer" are not taken into account. An LR test between the model with "Estimated Religiousness" and without it, indicates that the first model is preferred at the 5 percent level. The differences in BIC are not conclusive. The expected differential fertility between an agent who strongly care about religion (Estimated Religiousness = 3) and an agent who does not care about religion (Estimated Religiousness = 1) equals to 10,2%. The same kind of results are found with the ordered probit regressions where BIC differences indicates a strong preferences for the model which includes religiousness. Notice that, once again, the impact of the transmission of values into the family, is robust to the introduction of religious variables.

It appears that studying the impact of religion with the variable "Estimated Religiousness" is less conclusive than with the Church attendance. This is probably due to the inherent imperfections of this measure. However, whatever the chosen measure and the estimation strategy, exhibiting a strong religiousness always increases fertility, at least at the 5 percent level of confidence.

4.4 Alternative Samples

As mentioned in section 4, all women of the sample have not yet achieved their reproductive process at the moment of the study. This could imply some doubts about what is really measured. Indeed, the fertility of a woman older than 45 years old can be considered as a completed fertility while the fertility of a younger woman can be considered as a current fertility. Model 2 of the preceding section was run

on the subsample of women who achieved their reproductive process[36]. Intuitively, the distribution is less suspected to exhibit an excess of zero observations since this was greatly explained by the age of the respondent. Indeed, the Vuong test indicates that the Poisson regression model is preferred to the zero inflated Poisson regression model[37]. An ordered Probit regression model is also provided (see Table 6 in appendix).

In both models, strong religiousness still increases the expected fertility of the respondent. For example, as in the preceding section, the fertility differential between strong practicers (Office Frequency = 6) and agents who do not practice at all, is about 16%.

As mentioned in the discussion about the strategy of estimation, the effect of age is difficult to interpret when it is directly added in the regression. Nevertheless, a zero inflated regression model where the age of the respondent directly enters the determinants of the non zero counts in place of the age dummies, was run (see Table 7). The impact of age on expected fertility is obviously positive and significant. However, the impact of religiousness is smaller than for the dummies strategy and is significant only at the 5% confidence level. The impact of female's education is no more significant. This result seems to confirm that directly adding the age variable in the regression captures important effects that are independent from the simple position of the woman in her process of fertility. Indeed, it seems to capture, at least, the recent evolution of school enrollment. Despite this limitation, the effect of religiousness is also validated.

Finally, as in Brañas-Garza & Neuman [2006], the zero inflated Poisson regression

[36]This reduces the sample's size to only 943 observations. The reduction of the sample to women who have completed their fertility has been used, among others, by Melkersson & Rooth [2000] and Covas & Silva [2000].

[37]The Vuong Statistic equals 0.83.

model is also provided for the entire sample including men and women (Table 6). A dummy "Female" is introduced, it has a positive and significant impact on fertility. On the whole population, the variable "Office Frequency" is strongly significant but exhibits a smaller value than for the women's subsample: maximal differential fertility between strong religiousness and no religiousness equals 18,2%.

5 Conclusion

Studies of the French fertility at the micro level have always been truncated of their religious dimension. Indeed, the French law makes it very difficult to collect individual data on religious affiliation. The data set "Enquête Mode de Vie des Francais" allows, for the first time, to analyze the impact of religion on fertility in France. It also provides proxies for cultural transmission into the family: the fertility of the respondent's parent and the transmission of "Family Oriented Values". I show that having been raised in a religious family has no significant effect on fertility and considering oneself as a believer does not matter either. Religiousness, whatever the chosen measure, has a positive and significant impact on expected fertility. Women with strong religiousness has an 24 percent higher expected fertility than women without religiousness at all.

The present paper also validates usual predictions of family economics. The income of men has a positive impact on woman's fertility while the women's own income has a negative impact on her fertility. Moreover, the women's school attainment has a negative impact on their expected number of children.

Because the sample suffers from an under representation of Muslims, Jews and Protestants, the religious affiliation could not be properly investigate. Moreover, the ethnic origin of the respondent is not available in the dataset. Future works should

aim at building a specific dataset dedicated to the study of fertility behaviors in France where religious and ethnic informations would be collected. This would allow to make more precise measurement of fertility behaviors and of the impact of culture on it, culture encompassing a richer set of dimensions.

Table 1: Zero Inflated Poisson Regression Model

	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Female Income	-0.056	-0.052	-0.052	-0.050	-0.051	-0.051
	(4.28)***	(3.90)***	(3.92)***	(3.81)***	(3.83)***	(3.85)***
Male Income	0.030	0.028	0.028	0.028	0.029	0.028
	(3.61)***	(3.35)***	(3.39)***	(3.39)***	(3.46)***	(3.39)***
Small Town	0.127	0.128	0.129	0.129	0.125	0.123
	(3.14)***	(3.14)***	(3.17)***	(3.17)***	(3.08)***	(3.03)***
Live In Paris	-0.263	-0.242	-0.245	-0.246	-0.246	-0.241
	(4.34)***	(3.96)***	(4.00)***	(4.03)***	(4.03)***	(3.95)***
Primary Education	0.214	0.201	0.203	0.200	0.202	0.200
	(3.50)***	(3.28)***	(3.32)***	(3.25)***	(3.29)***	(3.27)***
Higher Education	-0.073	-0.06	-0.061	-0.062	-0.068	-0.067
	(1.55)	(1.27)	(1.28)	(1.30)	(1.43)	(1.41)
Never Married	-1.246	-1.242	-1.243	-1.234	-1.237	-1.239
	(13.03)***	(13.00)***	(13.00)***	(12.90)***	(12.92)***	(12.96)***
More Than 45	0.145	0.138	0.144	0.138	0.132	0.125
	(3.40)***	(3.24)***	(3.32)***	(3.19)***	(3.05)***	(2.91)***
Less Than 28	-0.724	-0.731	-0.740	-0.754	-0.756	-0.736
	(3.58)***	(3.50)***	(3.49)***	(3.43)***	(3.37)***	(3.42)***
Parental Fertility		0.034	0.034	0.034	0.034	0.033
		(2.36)**	(2.37)**	(2.37)**	(2.35)**	(2.33)**
Family Values		0.079	0.080	0.077	0.075	0.075
		(3.18)***	(3.22)***	(3.09)***	(3.04)***	(3.02)***
No Religion			0.047	0.079	0.090	
			(0.79)	(1.27)	(1.43)	
Believer				0.070	0.025	
				(1.72)*	(0.53)	
Office Frequency					0.032	0.032
					(1.98)**	(2.72)***
Constant	0.501	0.312	0.299	0.256	0.197	0.234
	(6.91)***	(3.26)***	(3.08)***	(2.56)**	(1.88)*	(2.30)**
Logit						
Age	-0.593	-0.630	-0.642	-0.664	-0.680	-0.648
	(5.43)***	(5.38)***	(5.36)***	(5.35)***	(5.33)***	(5.37)***
Higher Education	1.509	1.543	1.546	1.538	1.571	1.567
	(2.09)**	(2.09)**	(2.09)**	(2.07)**	(2.09)**	(2.11)**
Small Town	-1.349	-1.383	1.383	-1.39	-1.38	-1.38
	(2.24)**	(2.27)**	(2.26)**	(2.27)**	(2.09)**	(2.26)**
Constant	13.684	14.454	14.695	15.145	15.494	14.820
	(3.34)***	(2.83)***	(2.66)***	(2.34)**	(2.21)**	(2.59)***
Pseudo R	0,134	0,137	0,137	0,137	0,138	0,138
BIC	-8362	-8363	-8359	-8354	-8351	-8366
Vuong Statistic	(3.82)***	(3.80)***	(3.80)***	(3.76)***	(3.74)***	(3.76)***

* significant at 10%; ** significant at 5 %; * significant at 1 %
Absolute value of z stat in parentheses

Table 2: Ordered Probit Regression Model and OLS

	OProbit 1	OProbit 2	OProbit 3	OLS 1	OLS 2	OLS 3
Female Income	-0.089	-0.080	-0.080	-0.095	-0.085	-0.084
	(4.88)***	(4.38)***	(4.37)***	(5.14)***	(4.61)***	(4.60)***
Male Income	0.053	0.049	0.051	0.052	0.048	0.049
	(4.55)***	(4.25)***	(4.35)***	(4.42)***	(4.14)***	(4.22)***
Small Town	0.251	0.248	0.250	0.243	0.234	0.236
	(4.38)***	(4.32)***	(4.35)***	(4.09)***	(3.97)***	(3.99)***
Live In Paris	-0.374	-0.344	-0.350	-0.327	-0.299	-0.305
	(4.93)***	(4.51)***	(4.59)***	(4.35)***	(3.99)***	(4.06)***
Primary Education	0.340	0.318	0.321	0.514	0.487	0.489
	(3.47)***	(3.24)***	(3.27)***	(4.90)***	(4.68)***	(4.70)***
Never Married	-1.357	-1.363	-1.360	-1.053	-1.052	-1.048
	(16.00)***	(16.04)***	(15.95)***	(14.12)***	(14.22)***	(14.09)***
More Than 45	0.227	0.197	0.206	0.274	0.232	0.239
	(3.92)***	(3.36)***	(3.49)***	(4.54)***	(3.83)***	(3.92)***
Less Than 28	-1.422	-1.400	-1.410	-0.981	-0.949	-0.957
	(12.25)***	(12.04)***	(12.10)***	(10.17)***	(9.90)***	(9.96)***
Parental Fertility		0.060	0.060		0.059	0.058
		(3.02)***	(3.01)***		(2.87)***	(2.85)***
Family Values		0.143	0.145		0.132	0.134
		(4.10)***	(4.14)***		(3.73)***	(3.78)***
Office Frequency		0.039	0.040		0.060	0.062
		(2.00)**	(1.70)*		(3.00)***	(2.59)***
No Religion			0.143			0.122
			(1.59)			(1.49)
Believer			0.042			0.032
			(0.66)			(0.48)
Constant				1.604	1.138	1.089
				(15.89)***	(8.11)***	(7.56)***
Pseudo R2	0.144	0.149	0.15	0.295	0.31	0.312
(Adj R for OLS)						
BIC	-8482	-8492	-8480			

Observations 1793

Absolute value of z statistics in parentheses (t statistics for OLS)

* significant at 10%; ** significant at 5 %; * significant at 1 %

Table 3: Alternative Assumptions for the Zero Inflation

	Selected Model	Extended Model	Alternative 1	Alternative 2	Alternative 3
Female Income	-0.051	-0.050	-0.050	-0.050	-0.050
	(3.85)***	(3.76)***	(3.76)***	(3.77)***	(3.76)***
Male Income	0.028	0.027	0.027	0.027	0.027
	(3.39)***	(3.25)***	(3.25)***	(3.25)***	(3.25)***
Small Town	0.123	0.110	0.110	0.110	0.109
	(3.03)***	(2.68)***	(2.68)***	(2.68)***	(2.67)***
Live In Paris	-0.241	-0.231	-0.231	-0.231	-0.231
	(3.95)***	(3.75)***	(3.75)***	(3.76)***	(3.75)***
Primary Education	0.200	0.201	0.201	0.201	0.201
	(3.27)***	(3.28)***	(3.28)***	(3.28)***	(3.29)***
Never Married	-1.239	-1.235	-1.237	-1.236	-1.237
	(12.96)***	(12.27)***	(12.89)***	(12.30)***	(12.29)***
More Than 45	0.125	0.113	0.113	0.113	0.113
	(2.91)***	(2.62)***	(2.62)***	(2.63)***	(2.62)***
Less Than 28	-0.736	-0.564	-0.565	-0.567	-0.558
	(3.42)***	(3.15)***	(3.18)***	(3.18)***	(3.12)***
Parental Fertility	0.033	0.032	0.032	0.032	0.032
	(2.33)**	(2.26)**	(2.26)**	(2.26)**	(2.25)**
Family Values	0.075	0.076	0.076	0.076	0.075
	(3.02)***	(3.06)***	(3.06)***	(3.06)***	(2.98)***
Office Frequency	0.032	0.032	0.032	0.031	0.031
	(2.72)***	(2.70)***	(2.70)***	(2.69)***	(2.68)***
Constant	0.234	0.257	0.257	0.258	0.260
	(2.30)**	(2.53)**	(2.53)**	(2.53)**	(2.55)**
Logit					
Age	-0.648	-0.518	-0.521	-0.519	-0.518
	(5.42)**	(5.47)***	(5.76)***	(5.40)***	(5.39)***
Office Frequency		-0.07	-0.08		
		(0.22)	(0.28)		
Small Town		-1.651	-1.637	-1.631	-1.686
		(2.48)**	(2.56)**	(2.47)**	(2.52)**
Primary Education		-2.92			
		(0.00)			
Higher Education	1.567	1.57	1.541	1.612	1.557
	(2.11)**	(2.09)**	(2.09)**	(2.11)**	(2.12)**
Small Town	-1.38	-1.38	-1.38	-1.342	-1.414
	(2.26)**	(2.19)**	(2.26)**	(2.15)**	(2.29)**
Family Values		-0,123			
		(0.33)			(0.37)
Never Married		-0.24		-0.26	
		(0.29)		(0.31)	
Constant	14.820	13.060	13.134	13.122	13.093
	(5.37)***	(5.37)***	(5.71)***	(5.33)***	(5.30)***
Pseudo R	0,137	0,139	0,139	0,139	0,139
BIC	-8366	-8339	-8354	-8354	-8355

Observations 1793, * significant at 10%; ** significant at 5 %; * significant at 1 %
Absolute value of z statistics in parentheses

Table 4: Instrumental Variables for Female Income

	qb1	Female Income Regression
Female Income	-0.47	
	(3.04)***	
Male Income	0.141	0.207
	(3.81)***	(14.07)***
Less Than 28	-1.353	-0.961
	(7.31)***	(7.93)***
More Than 45	0.319	0.334
	(3.66)***	(4.16)***
Small Town	0.145	-0.199
	(2.01)**	(2.59)**
Live In Paris	-0.125	0.455
	(1.19)	(4.70)***
Primary Education	0.213	-0.445
	(1.74)*	(3.19)***
Never Married	-0.954	0.241
	(10.71)***	(2.51)**
Parental Fertility	0.032	-0.025
	(1.78)*	(0.96)
Family Values	0.087	-0.123
	(1.98)**	(2.68)***
Office Frequency	0.166	-0.036
	(2.37)**	(0.44)
Financial Expert		-0.133
		(2.69)***
Bank Loan		-0.550
		(4.57)***
Constant	1.85	2.350
	(7.24)***	(9.42)***
Sargan Statistic (all instruments)	7.68	
	(0.007)	
C-Statistic for qf18	7.68	
	(0.007)	
Adj R	0.1404	0.303
Difference in Sargan	(7.49)***	
Sargan Statistic	(7.49)***	
Durbin - Hausman - Wu test	-0.48	
(coefficient for residuals)	(3.42)***	

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 5: Alternative Measure of Religiousness

	ZIP 1	ZIP 2	ZIP 3	Oprobit 1	Oprobit 2	Oprobit 3
Female Income	-0.050	-0.050	-0.055	-0.080	-0.080	-0.087
	(3.79)***	(3.79)***	(4.17)***	(4.35)***	(4.34)***	(4.79)***
Male Income	0.030	0.029	0.030	0.052	0.051	0.052
	(3.53)***	(3.45)***	(3.62)***	(4.43)***	(4.31)***	(4.51)***
Less Than 28	-0.750	-0.734	-0.729	-1.410	-1.401	-1.419
	(3.45)***	(3.48)***	(3.57)***	(12.07)***	(12.02)***	(12.21)***
More Than 45	0.133	0.126	0.148	0.207	0.196	0.230
	(3.06)***	(2.91)***	(3.45)***	(3.48)***	(3.32)***	(3.95)***
Small Town	0.134	0.132	0.131	0.258	0.256	0.253
	(3.27)***	(3.23)***	(3.21)***	(4.47)***	(4.43)***	(4.38)***
Live In Paris	-0.244	-0.239	-0.260	-0.349	-0.342	-0.371
	(3.98)***	(3.91)***	(4.27)***	(4.56)***	(4.47)***	(4.88)***
Primary Education	0.174	0.171	0.192	0.288	0.285	0.317
	(2.78)***	(2.75)***	(3.09)***	(2.91)***	(2.87)***	(3.21)***
Never Married	-1.251	-1.252	-1.261	-1.372	-1.371	-1.369
	(12.92)***	(12.95)***	(13.04)***	(15.97)***	(16.01)***	(16.02)***
Parental Fertility	0.030	0.030		0.057	0.057	
	(2.10)**	(2.08)**		(2.83)***	(2.84)***	
Family Values	0.079	0.078		0.146	0.143	
	(3.14)***	(3.11)***		(4.15)***	(4.08)***	
No Religion	0.087			0.143		
	(1.39)			(1.75)*		
Believer	0.010			0.007		
	(0.20)			(0.10)		
Estimated Religiousness	0.059	0.056		0.094	0.083	
	(1.94)*	(2.29)**		(2.18)**	(2.40)**	
Constant	0.193	0.228	0.494			
	(1.81)*	(2.19)**	(6.78)***			
Pseudo R	0.138	0.138	0.134	0.151	0.15	0.145
BIC	-8257	-8270	-8268	-8379	-8391	-8381

Observations 1774, Results for Logit Deleted
Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%

Table 6: Alternative Samples

	Woman Older Than 45		Entire Sample		
	Oprobit	Poisson	Oprobit	OLS	ZIP
Female Income	-0.063	-0.037	-0.086	-0.090	-0.055
	(2.62)***	(2.25)**	(5.11)***	(5.33)***	(4.42)***
Male Income	0.024	0.010	0.057	0.055	0.032
	(1.60)	(1.03)	(6.86)***	(6.76)***	(5.37)***
Small Town	0.147	0.089	0.184	0.176	0.093
	(1.91)*	(1.75)*	(4.44)***	(4.16)***	(3.17)***
Live In Paris	-0.280	-0.175	-0.350	-0.298	-0.227
	(2.80)***	(2.38)**	(6.07)***	(5.30)***	(4.95)***
Primary Education	0.250	0.179	0.293	0.426	0.183
	(2.49)**	(2.86)***	(4.02)***	(5.55)***	(3.97)***
Never Married	-1.928	-1.758	-1.423	-1.072	-1.334
	(11.95)***	(8.83)***	(21.77)***	(19.36)***	(17.57)***
Parental Fertility	0.055	0.033	0.061	0.062	0.033
	(2.13)**	(1.88)*	(4.15)***	(4.16)***	(3.22)***
Family Values	0.140	0.062	0.120	0.111	0.062
	(3.00)***	(2.01)**	(4.63)***	(4.25)***	(3.40)***
Office Frequency	0.053	0.039	0.048	0.063	0.034
	(2.21)**	(2.45)**	(3.29)***	(4.19)***	(3.33)***
Less Than 28			-1.303	-0.827	-0.529
			(14.51)***	(11.59)***	(3.67)***
More Than 45			0.242	0.277	0.145
			(5.72)***	(6.40)***	(4.65)***
Female			0.345	0.331	0.210
			(5.18)***	(5.00)***	(4.42)***
Constant		0.448		0.763	0.016
		(3.75)***		(7.10)***	(0.20)
BIC	-3467	-3428	-18125		-17833
Observations	938	938	3358	3358	3358

* significant at 10%; ** significant at 5%; *** significant at 1%, Results for Logit Deleted
Absolute value of z statistics in parentheses (t statistics for OLS)

Table 7: Alternative Methods for Age

	Age in the Regression	Dummies Strategy
Female Income	-0.052	-0.050
	(3.93)***	(3.81)***
Male Income	0.035	0.029
	(4.14)***	(3.47)***
Age	0.008	
	(5.58)***	
Small Town	0.134	0.131
	(3.26)***	(3.21)***
Live In Paris	-0.239	-0.240
	(3.90)***	(3.92)***
Primary Education	0.106	0.174
	(1.64)	(2.79)***
Never Married	-1.239	-1.255
	(12.70)***	(12.98)***
Parental Fertility	0.037	0.031
	(2.59)***	(2.13)**
Family Values	0.080	0.077
	(3.20)***	(3.09)***
Office Frequency	0.084	0.115
	(1.98)**	(2.74)***
More Than 45		0.124
		(2.87)***
Less Than 28		-0.749
		(3.45)***
Constant	-0.110	0.239
	(0.87)	(2.34)**
Pseudo R	0,139	0,139
BIC	-8277	-8272

Absolute value of z statistics in parentheses
* significant at 10%; ** significant at 5%; *** significant at 1%
Results for Logit Deleted

General Conclusion

By analyzing the population issues, economists try to answer fundamental questions like: does an optimal size for humankind exist? Is a small population with high standards of living preferable to a larger but less happy population? Is the exponential growth in the number of humans a chance or a threat for his long run well being and survival? How can we explain the historical decrease in fertility which characterizes the demographic transition?

I provide, in the present thesis, a contribution to economists' continuous attempts at understanding the determinants of population growth and its implications for human well-being.

In chapter 1, I show that despite the extensive literature which has enriched seminal Beckerian model of trade-off between quality and quantity, its optimality properties have not been investigated. Providing this missing piece of the literature, I show that, in this model, subsidizing education always requires to implement a policy on births. This policy will consist in taxing births for a large set of Social Welfare functions like the Millian one. The existence of externalities on investments in education requires education subsidies. These subsidies, in turn, distort the net cost of children such that parents can exhibit a too high fertility rate. This distortion originates from the non linearity of the parental budget constraint with regard to quantity and quality.

In an extended version of the model, I make child mortality endogenous: parents can invest in health to reduce the children mortality they face when they choose their optimal trade-off between quality and quantity. In this framework, health is in another source of externalities. I show that, even though parents do not invest in their children's health enough at the competitive equilibrium, health expenditure should not always be subsidized. Indeed, the taxation of births plays the role of an indirect subsidy on health expenditures. As a result, when externalities on education are very high relative to positive externalities on health, the indirect subsidy on health can exceed the subsidy that is really needed. Then health expenditures have to be taxed.

In Chapter 2, I show that economists provide consistent explanations of the demographic transition. They propose alternative models to explain why population engage in the reduction of their fertility and, at least in developed countries, why they enjoy a long run growth of their income per capita. I argue, however, that these models cannot take into account one major determinant of the long run decrease in fertility: interactions between economic and cultural determinants of fertility.

The role of cultural factors in the European demographic transition has been largely evidenced by demographers, historians, sociologists and even anthropologists. To take this interaction into account, economists have to make individual preferences and their transmission endogenous. Dealing with non constant preferences is not usual for economists but a recent literature has engaged in this project.

Among others, Bisin & Verdier [2001] propose a framework making the cultural transmission and the dynamics of preferences endogenous. I propose, in chapter 2, a model à la Bisin & Verdier [2001]. I define alternative cultures following their members' preferences for quantity of children and their mode of production. Because

cultural transmission from parents to children is not perfect, I allow for mobility between cultural groups. Differential fertility between cultures gives rise to an evolutionary process while differential effort to transmit the parental culture gives rise to a cultural process. The long run distribution of preferences and the average total fertility rate in the population both result from interactions between these two processes.

As a result, a fertility transition cannot appear without productivity shocks in favor of the culture which is not biased toward quantity of children. However, these asymmetric productivity shocks are not always a sufficient condition to undergo a fertility transition. According to findings of demographers like Lesthaeghe [1986], this model allows to reproduce, at least, the impact of Catholicism and Calvinism on the fertility transition in Early Western Europe.

Above the evidence underlined by demographers and sociologists, the inclusion of culture as a determinant of population dynamics finds another support in a recent empirical literature. This literature investigates the impact of cultural variables, and especially religion, on fertility behaviors in a framework where the Beckerian conclusions are validated.

Chapter 3 provides a contribution to this literature thanks to an econometric study of the impact of religion and cultural transmission on individual fertility in France. Because of legal restrictions, usual microeconometric studies of French fertility suffer from the lack of data on religion. Thanks to the dataset "Enquête Mode de Vide des Français", chapter 3 constitutes the first attempt to measure the impact of religion on fertility behaviors in France, in a framework where usual Beckerian effect are controlled for.

My results show that having been raised in a religious family has no signific-

ant effect on fertility and considering oneself as a believer does not matter either. However, religiousness, whatever the chosen measure, has always a positive and significant impact on expected fertility. This effect is measured in two ways : the intensity of religious practice measured by attendance to religious office and the respondent's estimation, between zero and ten, of the importance of religion in her own life.

This chapter also validates usual predictions of family economics. The income of the male has a positive impact on woman's fertility while the woman's own income has a negative impact on her fertility. Moreover, the school attainment of women has a negative impact on their expected number of children.

In chapter 3, I contribute to a recent literature which provides empirical evidence in favor of the inclusion of endogenous cultural mechanisms in fertility models. The model of fertility and cultural transmission, from chapter 2, provides a framework for future research. One major weakness of this model comes from fertility norms which are exogenous and constant. Future works will aim at making them endogenous as in Lindbeck *et al* [1999] and Palivos [2001]. Fertility norms will be determined by average past and present fertility behaviors inside each culture.

Such a model will result in an even finer analysis of the interactions between cultural and economic variables which are at the heart of the long run decrease of fertility. Its calibration would also allow for the measurement of the long lasting effects of old and disappeared social norms of fertility on current fertility behaviors, for instance in Europe.

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